APPENDIX D:

Biological Monitoring Program

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Stillwater NWR Complex Biological Monitoring Program Summary

Preface

This appendix is intended to be a discussion of the general direction monitoring will proceed under alternative C of the draft Stillwater NWR CCP-EIS. The final version will contain protocol for each monitoring effort, field sheets, data storage requirements, analyses to be conducted, and linkage among created databases to address implementation of habitat management strategies outlined in the refuge CCP. Therefore, this appendix is meant to inspire discussion relative to refuge monitoring needs, whether the design of this plan is adequate to measure implementation success, and if we are asking (and monitoring) the right questions to address adaptive management during the 15-year life of the Stillwater NWR CCP..

Introduction

Past monitoring efforts on National Wildlife Refuges have generally focused on key species and habitats; typically those considered sensitive (e.g., endangered species) or those species identified in refuge establishing authorities (e.g., waterfowl, shorebirds), or otherwise deemed important. While these programs were adequate to identify trends in these higher priority species, more often than not, they failed to examine the refuge landscape holistically, and this did not identify all components common to the refuge environment. This is not to say that we should choose to study each organism at a high level of detail, as this would require many decades with a small army of biologists and/or outdoor recreation planners. Instead, we should carefully select the components we choose to monitor, ensuring that each component is representative of many other species/habitats (considered an indicator species) or that the component would not be represented through the indicator approach. Additionally, we should ask the right monitoring questions to ensure that we ultimately have the ability to critically analyze collected data, the means to measure our success at implementing refuge Comprehensive Conservation Plans (CCP), and that we have the flexibility to adapt as information directs us to alter existing management and monitoring approaches.

Under Alternative C of the Stillwater NWR CCP-EIS, we have been guided to examine the extent and restorability of natural functions and processes, with management emphasis on restoring and maintaining natural biological diversity. Additional, but equally important purposes include fulfilling international treaty obligations and providing opportunities for scientific research, environmental education, and fish and wildlife oriented recreation. These purposes were outlined under Public Law 101-618 Sec.206(4)(b)(2) and require specific monitoring protocol to ensure that we are fulfilling their intent.

Based on these purposes, three primary goals were established for Stillwater NWR under Alternative C including:

Goal A: Conserve and manage fish, wildlife, and their habitat to restore and maintain natural biological diversity. (4 subgoals)

Goal B: Contribute toward fulfilling obligations of international treaties and other international agreements with respect to fish and wildlife. (3 subgoals)

Goal C: Provide opportunities for environmental education and wildlife-dependent recreation that are compatible with refuge purposes and the Refuge System mission. (4 subgoals)

Along with two additional goals established for Anaho Island NWR:

Goal A: Protect and perpetuate colonial-nesting birds and other migratory birds.

Goal B: Restore and maintain natural biological diversity.

Under each established goal and subgoal, a series of objectives were developed which identify parameters used to measure our relative success in fulfilling purposes established under public law 101-618 as adapted for alternative C of the Stillwater NWR CCP-EIS. There are 49 draft objectives for Stillwater NWR related to wildlife and habitat (38 and 12 each for goals A and B), 25 are directly related to habitat, seven to wildlife, and 17 which are a combination of wildlife, habitat, and people management. Ultimately, all objectives relate back to wildlife; however, the emphasis on habitat follows the adopted management philosophy under Alternative C which is to restore and/or mimic natural processes.

U.S. Fish and Wildlife Service Policy

U.S. Fish and Wildlife Service monitoring and inventory plan policy (701 FW 2), indicates that four types of surveys are appropriate for station level monitoring plans. These range from Type I to Type IV surveys with definitions for each as follows:

Type I: Species Lists - All species known to occur on the refuge unit including plants, invertebrates, and vertebrate species groups. These lists should be updated annually with strategies developed to fill identified information gaps.

Type II: Qualitative Surveys - These are surveys where observational data only are obtained. In some instances, it is difficult to obtain data where trend or statistical analyses are difficult to perform (e.g., observation of rare or unusual species). These data should still be acquired and stored in programs such as AVISYS as they are useful for updating species lists as new species are documented.

Type III: Quantitative Surveys - These surveys are the backbone of a biological monitoring plan and provide the data necessary to examine long-term trends useful for adaptive management strategy development. These surveys must be carefully designed with rigorous statistical analyses developed to interpret the data. They can include monitoring efforts completed by refuge personnel, graduate students, or other outside research concerns, and should be of publication quality upon completion.

Type IV: Special Cooperative Surveys - these surveys include data sets collected on a refuge unit which are part of larger state, ecoregion, and national data collection efforts. Examples appropriate to Stillwater NWR complex include, breeding bird surveys, shorebird surveys, Christmas bird counts, bird banding efforts, and contaminants monitoring conducted in conjunction with a variety of local, state, private, and other Federal organizations.

The vast majority of monitoring procedures described in this Inventory and Monitoring Plan will produce Type I or III data sets with minimal emphasis placed on Type II efforts. Preexisting Type IV cooperative efforts will be continued as they lead to an understanding of wildlife populations on a landscape scale with direct applicability to populations occurring on Stillwater NWR.

General Strategies to Implement Program

Monitoring strategies can broadly be described under six program areas including literature search and baseline inventory, water monitoring, habitat monitoring, wildlife censuses, outside research, and comparisons with objectives monitored under the public use monitoring program (Table 1). The preceding list follows a hierarchical approach based on our current needs and our level of understanding of natural conditions surrounding each parameter. For example, our primary current need is literature searches and baseline inventory information on parameters selected for observation under Alternative C. Many of the target groups have not been monitored in the past, but are integral to ensuring we are monitoring as much of the system as is reasonably possible. This will be the first level of monitoring needs within this plan.

Following these initial inventories, water, habitat, and wildlife monitoring strategies are ordered based on our understanding of each individual component. This roughly equates to a knowledge continuum where our best existing data and understanding of natural function is related to water movement, followed by habitat, and then by wildlife populations. Few data are available to estimate what historic or natural population levels were for most wildlife species on Stillwater NWR; however, through simulation of natural hydrological characteristics, it is assumed that native plant communities will form, providing habitat for the natural complement of wildlife species which are associated with the natural system. It is understood that historic hydrologic function cannot be restored on Stillwater NWR, but monitoring should provide the data to determine whether we are moving towards this desired goal. The following sections will provide a discussion of the basic elements involved in each of the different monitoring areas. Completion of all biological monitoring objectives are based on the following minimum staffing requirements identified in the Stillwater NWR CCP-EIS.

GS-11	PFT	Wildlife Biologist
GS-9/11	PFT	Wildlife Biologist
GS-7/9	PFT	Wildlife Biologist
GS-5	TPT	Biological Technician (6 month's)
2-4	Volunteers/3 months	

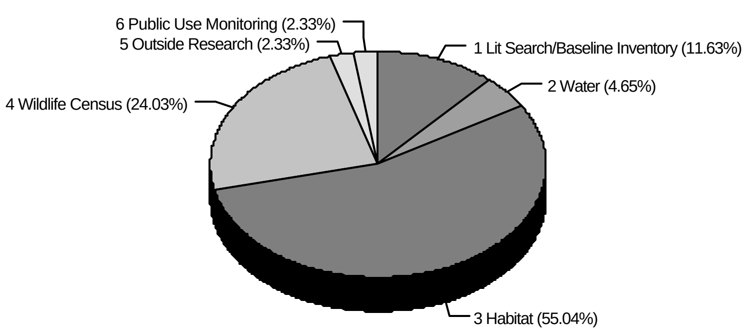
Literature Search and Baseline Inventories

Over the past several years, efforts have been made to collect baseline information on a variety of communities inhabiting Stillwater NWR including aquatic and terrestrial invertebrates; upland, wetland, and riparian vegetation; bats; butterflies; small mammals; leopard frogs; snowy plover; fish; saltcedar; as well as a variety of other species. Many of these inventories were comprehensive and provided much of the information used in developing the refuges comprehensive conservation plan. While these exercises have been valuable, it is understood that they only represent one point in time and some inventories, failed to locate and/or generate population estimates for target species/communities that accurately reflect their natural representation at the refuge.

Early phases of monitoring plan implementation will consider species or species groups where we have little to no baseline information available and utilize volunteer and/or outside research organizations to initiate data collection. Monitoring targets including aquatic mammals, predators (mammalian and avian), amphibians, reptiles, and plants will have baseline inventories and literature searches conducted as soon as individuals are identified to complete the project; however, additional scoping will be conducted by Stillwater NWR biological staff to identify other baseline requirements to implement this monitoring plan.

Table 1: Broad program areas under which monitoring protocol will be developed and number of objective monitoring requirements satisfied by each technique.

Program Area	USFWS Monitoring Protocol Used	Number of Objectives Monitored
Literature Search/Baseline Inventory	Types I and II	15
Water Monitoring	Type III	6
Habitat Monitoring	Type III	41
Wildlife Census	Types III and IV	26
Outside Research	Type III	3



Water Monitoring

Water distribution is the primary management tool used at Stillwater NWR to meet the goals outlined in the refuges draft CCP-EIS. Timing, amount, duration, and location of inflow are key elements to achieving wetland acreage and habitat targets, and monitoring procedures must be designed to ensure we are in compliance with the stated objectives. Additionally, contaminant concerns have been identified in many of the refuge wetlands, riparian areas, and delivery canals which could lead to potential effects to breeding species using refuge habitats. Therefore, a combination of flow monitoring, measurement of overall wetland acreage provided in different seasons, and contaminants monitoring will be the primary facets involved in the water monitoring component of the refuges biological monitoring plan.

Water flow monitoring will be conducted weekly. Flow rate, measured in cubic feet/second (cfs), will be measured at all refuge input points and all refuge water control structures. Each month, total dissolved solids (TDS), pH, and total dissolved oxygen will be measured to index quality of the water entering refuge habitats. Additional efforts to characterize contaminant relationships with water quality will be conducted by the contaminants branch of the FWS with periodic studies conducted to identify contaminant levels in various biological communities. Through remote sensing analysis, this information will be compared to seasonal wetland acreage with flow characteristics compared to wetland acres produced. Contaminant concern wetland units or areas will be mapped to identify long-term trends in contaminant concentrations relative to water management strategies. This information will ultimately be used to predict vegetation response to water management to help fulfill habitat objectives identified in the following section.

Habitat Monitoring

Considering that a wide variety of upland, riparian, and wetland habitats are juxtaposed throughout a 170,000 acre NWR, intensive field sampling is not an appropriate method to monitor annual changes in habitat. Instead, a combination of remote sensing; permanent and random quadrats; line transecting, and cruising will be used. Remote sensing (aerial imagery analysis) will form the backbone of the habitat monitoring program with analysis intensity directly related to anticipated changes in vegetation communities. For example, wetland habitats are expected to fluctuate widely, therefore, biannual analysis occurring in spring and early fall will be completed. Conversely, upland habitats are not expected to change as dramatically and subtle changes (e.g., grass communities in the shrub understory) would likely not be detected. For these habitats, aerial imagery analysis would be completed every five years with a combination of quadrat sampling, line transecting, and cruising used to interpret subtle changes in understory vegetation. Strategies to implement quadrat and line transect methodologies for all Stillwater NWR habitat types are offered in Table 2. Cruising will be used to monitor distribution and abundance of invasive species as well as to document presence of rare species, or species of limited distribution.

Wildlife Monitoring

While water management and the habitats produced are a primary focus of the biological monitoring program, it is equally important to document the fish and wildlife populations utilizing these habitats. A variety of census, survey, and wildlife marking procedures will be used to perform 26 separate wildlife census, survey, and marking efforts annually (four are currently conducted by outside organizations but may be incorporated as staff responsibility in future years). Monitoring efforts will focus on a proportional combination of avian, mammalian, amphibian, fish, reptile, invertebrate, rare species, and baseline population inventories requiring an estimated 186 - 245 total staff days to complete which should be easily fulfilled by the minimum biological staffing requirements outlined earlier in this discussion. Rather than describe each individual wildlife monitoring approach, Appendix 1 offers the target guilds/species to be monitored, the general techniques to be used, the timing and intensity of survey implementation, the staff days required, and the party responsible for data collection.

Table 2: Sampling methodology and intensity used to monitor Stillwater NWR wetland, upland, and riparian habitats defined in the Stillwater NWR CCP-EIS.

Wetland	**Deep, Open Water**	Quantified through aerial imagery analysis
	Submergent	Line transects previously established in all refuge units (13 units).
	Deep Emergent	Extension of submergent line transects and random placement of 10 quadrats to verify species composition
	Shallow Emergent	Extension of submergent line transects and random placement of 10 quadrats to verify species composition
	Moist-Soil	Random placement of 20 quadrats to verify species composition
	Wet Meadow	Random placement of 20 quadrats to verify species composition and continuation of 20 quadrats at Fallon NWR grazing study site
	Wetland Shrub	Random placement of 10 quadrats to verify species composition
	Unvegetated Alkali Mudflat	Quantified through aerial imagery analysis
	Playa	Quantified through aerial imagery analysis
Riparian	**Riverine Channel and Tree Communities**	Establishment of 20 permanent 100 m cross-sectional transects sampled at 10 m intervals and random placement of 10 quadrats to verify species composition
	Seasonal Overflow	Random placement of 10 quadrats to verify species composition
	Riverine Delta	Random placement of 10 quadrats to verify species composition
Upland	**Greasewood Shrubland**	Establishment of 5 permanent 1000 m transects sampled at 10 m intervals
	Saltbush Desert Shrubland	Establishment of 5 permanent 1000 m transects sampled at 10 m intervals
Sand Dunes	**Sand Dunes**	Establishment of 5 permanent 1000 m transects sampled at 10 m intervals

Outside Research

While a comprehensive inventory of refuge resources will be completed through implementation of the procedures described in the biological monitoring plan, there are some areas that require more intensive effort and/or specialized expertise. For example, contaminant monitoring falls outside the scope of what Stillwater NWR biological staff can reasonably and efficiently accomplish. Therefore, contaminant sampling will be administered by FWS contaminants personnel with analyses to be contracted out to an independent laboratory. Cooperative agreements have been developed in the past with the University of Nevada-Reno, to assess upland vegetation and faunal community distribution. A graduate student from Louisiana State University collected intensive life history information on white-faced ibis. In the future, research questions addressing interactions among wildlife and the visiting public, Indian ricegrass and kangaroo rats, and the relationships between deep emergent vegetation stands and overwater nesting birds should be answered. These questions, as well as other complex research questions anticipated to arise are best suited to cooperative efforts, typically lead by outside research organizations. Priority will be given to projects specifically addressing Stillwater NWR research needs; however, proposals submitted for other research purposes will be encouraged and reviewed for implementation on a case by case basis.

Anaho Island NWR

While evaluating monitoring needs for Anaho Island NWR, six objectives combined between protecting colonial nesting species and restoring and maintaining natural biological diversity were identified. From these objectives, eight preliminary monitoring strategies were developed (Appendix 2). These eight procedures can be fulfilled through a combination of remote sensing, ground census, line transecting, baseline inventory techniques, and by cooperation between refuge staff and outside research entities. Results from baseline inventory/outside research efforts will be used to identify additional biological monitoring needs and to refine monitoring protocol as the data indicate. Long-term data sets collected by outside research concerns should be obtained and compared with Anaho Island biological monitoring data. Approximately 38-49 staff days distributed among the GS-11 Anaho Island NWR manager and Stillwater NWR complex biological staff, will be required to complete this plan. The addition of an Anaho Island wildlife biologist would allow for increasing effort in future years.

Other Monitoring Efforts and Summary

In addition to the biological monitoring program, a Stillwater NWR Public Use Monitoring Plan will be developed. The data collected under this program can be compared with biological monitoring components to assess interactions between these broad program areas. All components from each program will be entered and stored within a developing, relational database manager which will allow for data analyses within and among monitoring efforts. These analyses can then be used to develop adaptive management strategies for future years and are intended to be incorporated in annual step-down management plans for water, habitat, and public use. The efforts described in this biological monitoring program summary should provide the data required to perform the necessary analyses; however, as the database manager develops, flexibility will be left into the plan to adapt monitoring strategies as shortfalls are identified or more refined protocol are developed.

In summary, 49 objectives related to habitat and wildlife were developed from 3 goals for Stillwater NWR and 2 for Anaho Island NWR under Alternative C of the Stillwater NWR CCP-EIS. Monitoring protocol to measure our relative success at fulfilling these objectives were divided among five areas including literature search/baseline inventory, water monitoring, habitat monitoring, wildlife censuses, and outside research. A series of techniques will be developed within each of these categories which are consistent with USFWS monitoring policy (701 FW 2) and will encompass a combination of Type I through Type IV survey protocol. Primary emphasis will be on monitoring habitat objectives; however, within each category, a more equal focus on the variety of habitats and wildlife species inhabiting Stillwater and Anaho Island NWR's will be accomplished. Data collected from these monitoring efforts will be recorded and stored in a relational database manager, with analyses used to develop adaptive management strategies for water, habitat, and public use management. This summary does not provide much detail on the protocol to be used within the plan; however, Appendix 3 provides the list of objectives, the broad approach to be used, the target species/guilds to be monitored, and a condensed description of the monitoring procedures to be used.

Appendix 1: Past wildlife monitoring efforts, sampling period, intensity, staff days required, and additions/reductions to biological monitoring program.

Target Species/Guild	Broad Technique	Time of Year	Sampling Intensity	Staff Days Required	Organization	Adjustment
Avian Species/Guilds				35 - 46 staff days		
Waterfowl Population Inventory	Aerial Census	August - April	Monthly	None	NDOW	None
Waterfowl Breeding Pair Survey	Aerial Census	May	Single Count	None	NDOW	None
Waterfowl Brood Survey	Vehicle Census	May - August	Opportunistically w/coordinated late summer count	3-8	Refuge	Increase to index nesting success
Waterbird Banding	Trapping/Airboat	July - September	Opportunistically during summer	5-8 nights	Refuge	None - possible reduction
Goose Neck Collar Observation	Vehicle Census	October - January	Opportunistically	2-3 days	Refuge	Targeted reduction
Swan Census	Vehicle Census	October - March	Monthly	4-7 staff days	Refuge	Targeted reduction
Waterfowl Nest Searches	Nest Searches	April - July	Opportunistically	5-10 staff days	Refuge	Eliminated
Colonial Nesting Waterbird Breeding Pair Survey	Aerial Census	June	Single Count	None	NDOW	None
Shorebird Fall/Spring Population Inventory	Airboat/Ground	April, August	Two Counts	3-4 staff days	Refuge/NDOW	None
Snowy Plover Survey	Ground Survey	July	Single Count	2 staff days	Refuge	Addition
Mourning Dove Call Count	Ground/Call Count	June	Single Count	1 staff day	NDOW/Refuge	Eliminated
Bald Eagle Count	Ground/Roost Survey	October - March	Monthly	3-6 staff days	Refuge	Increased
Raptor Survey	Ground Count	Jan, Apr, Jul, Oct	Quarterly	4 staff days	Refuge	Increased
Avian Predator Survey (Raven)	Ground Count	April - June	Monthly	3 staff days	Refuge	Addition
Neotropical Migrants	Mist Netting	August - September	Daily	None	Partners in Flight Cooperators	None
Waterbird Migration Chronology	Ground Count	January - December	Bi monthly	48 staff days	Refuge	Addition

Disease Monitoring	Airboat Patrol	July - Sept, Dec - Apr	Opportunistically	16 - 48 staff days	Refuge	None
Species/Guild	**Broad Technique**	**Time of Year**	**Sampling Intensity**	**Staff Days Required**	**Organization**	**Adjustment**
Mammal Species/Guilds						
Coyote/Predator Survey	Trail indicator	May - July	Monthly	3 staff days	Refuge	Addition
Small Mammal Survey	Live Trapping	June - August	monthly (3 days)	5 - 9 staff days	Refuge	Addition
Muskrat Survey	Aerial/Ground Census	Jan, Apr, Jul, Oct	Quarterly	4 staff days	Refuge	Addition
Bat Species Survey	Mist Net/Observation	June	Single Count	2 staff days	Refuge	Addition
Amphibian Species/Guilds						
Leopard frog/Bullfrog Surveys	Call Count	April - June	Monthly	3 staff days	Refuge	Addition
Spadefoot Toad Survey	Sweep Net Samples	April - June	Opportunistically	1 staff day	Refuge	Addition
Fish Species/Guilds						
Tui Chub/Mosquitofish Index	Minnow Trap	May, August	Monthly	2 - 4 staff days	Refuge	Addition
Carp/Gamefish Index	Electroshock	May, August	Monthly	2 - 4 staff days	Refuge/NDOW	Addition
Reptile Species/Guilds						
Lizard/Snake Population Index	Pitfall Trapping	June - August	Monthly	4 - 9 staff days	Refuge	Addition
Invertebrate Species/Guilds						
Terrestrial Invertebrates	Pitfall Trapping	June - August	Monthly	With above	Refuge	Addition
Water Column Invertebrates	Sweep Net Samples	May, August	Two Samples	5-10 staff days	Refuge	Addition
Benthic Invertebrates	Benthic Core Samples	May, August	Two Samples	With Above	Refuge	Addition
Rare Species Inventory						
Nevada Viceroy/Other Butterflies	Sweep Net Samples	June, July	Two Samples	2-4 staff days	Refuge	Addition
Other Baseline Inventories						
2 Conducted Annually	Various Techniques	June - August	Variable	60 volunteer days	Refuge	Addition

Appendix 2: Minimum monitoring requirements for the Anaho Island Biological Monitoring Plan.

Monitoring Parameter	Broad Technique	Time of Year	Sampling Intensity	Staff Days Required	Organization
Biannually map Anaho island to document changes in island size, vegetation distribution, and colony location.	Aerial Photographs	May 1 and August 15	2 photo sessions	None	Outside Contractor will provide aerial photos
Document vegetation distribution relative to exotic species encroachment and native species restoration.	Vegetation Transects	March 1 and October 15	2 sampling sessions	2-4	Refuge
Colonial nesting waterbird counts	Ground Census, Photographs	March 15 -Sept 15	Bimonthly (13 counts)	26 staff days	Refuge
American white pelican banding	up to 400 juveniles annually	Mid June - Late July	2 banding periods	10 staff days	Refuge/Cooperators
Small Mammal Surveys	Live Trapping	March 1 and October 15 coordinated with vegetation sampling	2 sampling sessions	2-4	Refuge
Neotropical Migrant Surveys	Point intercept	March 1 and October 15 coordinated with vegetation sampling	2 sampling sessions	2-4	Refuge
Seasonal Wildlife Distribution	Cruising	Between October 15 and March 15	3 sampling sessions	3 staff days	Refuge
Baseline Inventory and Outside Research	Various techniques	Year Around	As Needed	5-10 staff days	Refuge/Outside Cooperators
TOTAL				**50-61 staff days**	

Appendix 3: Goals, subgoals, and objectives outlined in the Stillwater NWR CCP-EIS; and the broad approach, resources monitored, and monitoring procedures used to measure our success at achieving objectives.

Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Goal A: Conserve and manage fish, wildlife, and their habitat to restore and maintain natural biological diversity			
Subgoal A.a: Approximate a natural diversity within and among animal communities on Stillwater NWR	Estimate historic population levels, determine baseline population levels, and identify indicator species to monitor for each objective.		
Objective A.a.1 Restore and perpetuate the presence of all native species and native guilds of birds, mammals, reptiles, amphibians, fish, and invertebrates according to season.	Literature Search Indicator Species Baseline Inventory	Waterbirds, Upland birds, mammals, herps, invertebrates (T and A)	Following literature search, perform baseline inventories on species lacking information, continue protocol developed for these species.
Objective A.a.2: Restore and perpetuate population levels (or, use level of refuge) by each species to relative-abundances that would exist under natural conditions, recognizing natural fluctuations in populations	Literature Search Indicator Species	Waterbirds, Upland birds, mammals, herps, invertebrates (T and A)	Perform baseline inventories on species lacking information, continue protocol developed for these species.
Objective A.a.3: Minimize distribution and abundance of nonnative animal species and their prominence in fish and wildlife communities.	Nonnative Indicator Species	Carp, mosquitofish, game fish, bullfrogs, beaver	Annual fish surveys to assess relative ratios of native/non-native species. Annual amphibian surveys to assess the leopard frog/bullfrog ratio. Cruise riparian areas to estimate beaver abundance.
Subgoal A.b: Approximate, within a natural range of variability, a natural diversity within and between plant communities and habitat types	Estimate historic abundance and distribution, determine baseline abundance and distribution, and biannually map distribution of habitat types		
Objective A.b.1: Restore and perpetuate the presence of all native plant species and native plant communities in Stillwater Marsh, Battleground Marsh, Carson river corridor, Stillwater slough corridor, dune complex, and salt-desert shrub uplands	Rare Plant Inventory Remote Sensing	Wetland, Upland Shrub, Riparian, Sand Dune	Develop and initiate rare plant inventory for sand dune habitats, remap upland and riparian habitats every 5 years, biannually map and ground truth wetland habitats.

Goal	**Broad Approach**	**Resources Monitored**	**Monitoring Procedures**
Objective A.b.2: Approximate and perpetuate the presence of all native plant species that would occur on Stillwater NWR under natural conditions - within a natural range of variability - including representation by all native plant communities and habitat types, amount of area occupied by each plant community and habitat type, and the distribution and pattern (shape) of each.	Literature Search and existing literature Quadrats Remote Sensing	Wetland, Upland Shrub, Riparian, Sand Dune	Use existing literature on upland, wetland and riparian habitats as a baseline, revisit selected plots annually to monitor changes within communities. Establish permanent plots in sand dune and riparian habitats.
Objective A.b.2(a): Attain and sustain a long-term average of 14,000 acres of wetland habitat on Stillwater NWR, including marsh, shallow lake, and riverine wetland habitat.	Remote Sensing	Wetland and riparian habitats	Biannually photograph and map distribution of wetland habitats in spring and fall.
Objective A.b.2(b)(i): Attain and sustain a long-term average of 13,500 acres of wetland habitat in Stillwater Marsh in a way that attains the following seasonal targets: - 75-100% of peak acreage April-June (peak in late March/early April) - 40-70% of peak acreage July-September (>50% in July) - 55-70% of peak October-February	Remote Sensing Ground Estimates	Wetland and Riparian habitats	Use biannual wetland maps to estimate spring/fall habitat acreage, obtain monthly acreage estimates on all wetland units in conjunction with water distribution data.
Objective A.b.2(b)(ii): Approximate the natural mix of wetland habitat types and plant communities in Stillwater Marsh.	Literature Search Remote Sensing Line Transect Quadrats	Wetland, Riparian	Use biannual wetland/riparian photos to estimate extent of native habitat types, annually monitor established quadrats to document within community changes. Continue wetland line transects to estimate across wetland community distribution.
Objective A.b.2(b)(iii): Within 5 years, examine the feasibility and, if appropriate, develop a plan to restore native wet-meadow habitat in the area of the Kent and Weishaupt properties.	Management Plan Baseline Inventory Quadrats	Wet Meadow Habitats	Complete baseline inventory of plant species common to potential restoration areas. Establish permanent quadrats to track vegetation changes.
Objective A.b.2(c)(i): Attain a long-term average of 50-100 acres of riverine-wetland habitat on Stillwater NWR.	Remote Sensing	Riverine/Riparian Habitats	Use biannual wetland habitat maps to assess spring/fall riparian habitat acreages.
Objective A.b.2(c)(ii): Restore cottonwood, mesic shrub (willow, rose, buffaloberry), wet meadow, riverine-aquatic communities to their natural distribution and extent along the lower Carson river and Stillwater slough.	Literature Search Remote Sensing Active Management Quadrats	Riparian Habitats	Complete literature search on historic composition of riparian communities. Biannually map riparian habitat types. Establish permanent quadrats to assess within community changes.
Objective A.b.2(d)(i): Attain a long-term minimum average of 400 acres of wetland habitat in the Battleground marsh.	Remote Sensing	Riparian/Wetland Habitats	Biannually map extent of riverine delta/wet meadow habitats at the Battlegrounds.

Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Objective A.b.2(d)(ii): During years when water reaches the Carson river delta via Carson river, approximate natural habitat conditions.	Existing Literature Remote Sensing	Riparian/Wetland Habitats	Use existing data to estimate historic distribution of habitat types, biannually photograph and map existing types, establish permanent quadrats to track community changes.
Objective A.b.2(e): Restore, approximate, and maintain the natural distribution and abundance of upland plant communities and habitat types that would exist naturally, according to location, throughout upland portions of the refuge.	Existing Literature Remote Sensing Quadrats	Upland/Sand Dune Habitats	Use existing literature to estimate natural distribution of upland habitat types, map distribution of upland communities every five years, establish permanent quadrats to assess within community changes.
Objective A.b.3: Approximate within each habitat type and plant community, a natural species composition; emphasizing the domination of these communities by one or more native species representative of the community.	Quadrats Line Transect	Upland/Sand Dune Habitats	Establish and annually monitor permanent quadrats in upland habitats.
Objective A.b.3(a): For each habitat type and plant community, determine the approximate proportion that each of the major plant species should comprise in the community, and develop targets based on this assessment.	Literature Search Quadrats	Wetland, Riparian, Upland Shrub, Sand Dune	Review existing literature to determine components of identified plant communities. Use quadrat sampling to confirm within community distribution and to define new plant communities as observed.
Objective A.b.3(b): Prevent the establishment of any nonnative species not already present within the boundaries of Stillwater NWR, especially species listed as noxious weeds (e.g., purple loosestrife, Eurasian water milfoil).	Cruising Remote Sensing Other vegetation surveys	Wetland, Riparian, Upland Shrub, Sand Dune	Use all available resources to detect presence and spread of invasive exotic species on Stillwater NWR.
Objective A.b.3(c): Curtail the spread of noxious weeds and other invasive exotic vegetation within the Stillwater NWR, and reduce the amount of area dominated by saltcedar and perennial pepperweed.	Remote Sensing Quadrats	Wetland, Riparian, Upland Shrub, Sand Dune	Remap extent of noxious weeds every five years. Establish permanent quadrats to assess success of control efforts.
Objective A.b.4: Approximate, within each habitat type and plant community, the vegetative structure of plant communities that would occur under natural operation of ecological processes (e.g., spring flooding, drought, succession and competition, accumulation of residual plant material, herbivory, seed caching, long intervals between fires).	Literature Search Remote Sensing Quadrats	Wetland, Riparian, Upland Shrub, Sand Dunes	Through literature search, determine the extent, timing and frequency of natural processes, track simulations of these processes (natural and induced through management), and establish permanent quadrats to assess plant community structure in relation to process occurrence.
Stillwater Marsh			

Goal	Broad Approach	Resources Monitored	Monitoring Procedures
(i) a natural pattern of emergent vegetation and open-water areas in the marsh that is maintained by deeper channels and by disturbances such as spring flooding and muskrat grazing, or secondarily, a mosaic that simulates natural disturbances	Remote Sensing Line Transect	Emergent, Submergent, and deep open-water habitats.	Biannually map the extent of emergent, submergent, and deep open-water habitats, continue annual submergent vegetation transects to quantify structure and species composition within these communities.
(ii) portions of the marsh having residual vegetation that has accumulated for many years (e.g., five years or more).	Remote Sensing Water Mgmt Records	Wetland Habitats	Biannually map wetland habitats and track consistency of habitat types among years.
Lower Carson River and Stillwater Slough			
(i) An overstory of cottonwoods and/or willows along most stretches	Remote Sensing Quadrats	Riparian Habitats	Biannually map riparian habitat distribution, establish permanent quadrats to monitor vegetation change among years
(ii) An understory of native grasses and grass-like plants, forbs, and young cottonwoods and mesic shrubs	Quadrats Line Transects	Riparian Habitats	Establish permanent quadrats to assess changes in understory habitats not visible from aerial photographs. Potentially establish line transects to cover
(iii) Some areas dominated by grasses and grass-like plants (no woody overstory)	Remote Sensing Quadrats Line Transects	Riparian Habitats	Biannually map distribution of short statured habitat types. Establish permanent quadrats to assess changes in structure and species composition.
(iv) Carry-over of native herbaceous plant material from season to season and year to year during most periods, recognizing that spring flooding would naturally have matted some vegetation and induced decomposition, and that fires (late summer or fall) would have been infrequent)	Remote Sensing	Riparian and Wet Meadow Habitats	Biannually map wetland habitats to assess relative age of different habitat types and communities.
Uplands			
(i) Any overstory of native shrubs in many communities	Remote Sensing	Upland Shrub Habitats	Map distribution of perennial upland shrub habitats every five years
(ii) Extensive amounts of bare soil between shrubs in many communities	Remote Sensing Quadrats	Upland Shrub Habitats	While the potential exists to map distribution of bare soils through aerial photos, this should be verified through establishment and annual monitoring of permanent quadrats.

Goal	Broad Approach	Resources Monitored	Monitoring Procedures
(iii) A build up of residual plant material from native grasses and forbs, allowed to accumulate naturally over the years (i.e., not grazed or trampled by livestock, crushed by off-road vehicles, etc...)	Quadrats Line Transects	Upland Shrub Habitats	Annually monitor permanent quadrats to assess build-up of residual vegetation. Establish line transects to assess disturbance effects on upland vegetation.
Objective A.b.5: Approximate water conditions that would occur naturally, according to location of wetland-habitat (i.e., fresh in riverine and the upper end of marsh, and brackish at the lower end of marsh), in a way that contributes toward the approximation and maintenance of the natural extent, distribution, composition, and structure of plant and animal communities.	Existing Literature Water Mgmt Records Remote Sensing	Wetland and Riparian Habitats	Assess historic hydrologic processes through existing literature search, track water receipts and irrigation data to determine our success at simulating these processes. Biannually map habitat types through aerial photography.
Objective A.b.5(a): Maintain total dissolved solids (TDS) concentrations of Stillwater NWR inflows of less than 500 mg/L during February-June and less than 1,000 mg/L during the remainder of the year. Maintain low TDS levels in the upper Stillwater Marsh (generally <1,000 mg/L) and portions of the mid and lower Stillwater marsh that are within the flow route of water (<5,000 mg/L). Off-channel areas would have much higher TDS levels, possibly approaching 100,000 mg/L.	Remote Sensing Water Quality Samples	Wetland and Riparian Habitats	Use biannual mapping to index salinity ranges through occurrence of wetland habitat types. Take monthly measurements of water conductivity in conjunction with water monitoring procedures.
Objective A.b.5(b): Minimize the amount of contaminants entering Stillwater NWR wetlands and reduce mercury levels in wetland sediments to less than 1.5 ppm (<u>note</u>: TDS concentrations of inflow in excess of objective levels are viewed in the context of contaminants).	Water Quality Samples	Wetland and Riparian Habitats	Cooperate with the Reno Field Office to conduct contaminant surveys annually.
Subgoal A.c: Allow and provide for natural types, levels, rates, and distributions of biotic processes, such as herbivory, granivory, predation, population fluctuations of resident wildlife, and production; minimize or exclude processes not natural to the area or that are above or outside the levels, rates, locations, or communities that would occur naturally. Exceptions to this include: (1) diseases such as botulism and cholera, which would be minimized; and (2) browsing by deer and other wildlife may be controlled, to allow the reestablishment of native vegetation.	Estimate and provide descriptions of natural process occurrence levels, determine baseline departures from historic, and annually monitor identified key processes and functions.		
Objective A.c.1: Prevent grazing and browsing by nonnative herbivores that are above natural levels (use and distribution) for any given plant species and community, and season for these species and communities.	Existing Literature Cruising Grazing Exclosures	Upland, Wetland, Riparian, and Sand Dune Habitats, Livestock grazing permits	Determine relative levels and seasons of grazing under natural conditions, Cruise habitats to determine existing levels of use, biannually monitor exclosure plots and compare with quadrats established for other objectives.

Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Objective A.c.2: Allow native herbivores to graze and browse at natural levels (use and distribution).	Literature search Remote Sensing Indicator species census	Wet meadow and riparian habitats Mule deer, Canada geese, small mammal populations	Search literature to estimate natural population levels of native herbivores. Estimate availability of wet meadow and riparian habitats relative to forage availability. Monitor population levels of mule deer, Canada geese, and small mammals as indicators of natural herbivory.
Objective A.c.3: Prevent depredation of nests above natural levels when caused by unnaturally high populations of predators. (This objective does not include taking action when other factors are causing unnaturally high depredation rates, such as lowered habitat quality.)	Existing Literature Remote sensing Predator surveys	Upland, Wetland and Riparian habitats	Determine availability of upland and over-water nesting habitat. Perform literature search to estimate natural population levels for common raven and coyote. Monitor common raven and coyote populations on the refuge.
Objective A.c4: Prevent human disturbances that would measurably affect the use of the refuge by native wildlife, nest success of waterbirds and riparian birds, overall production, daily activity patterns of birds, use of important feeding habitats by waterbirds during migration and winter and the nutritional status of these birds, and other biotic processes.	Public Use Monitoring Distribution Census Time Activity Budget	Wetland and Riparian Habitats	Determine for each activity, timing, frequency, and relative use level within different refuge habitat types. Correlate these activities with wildlife distributions collected for the waterbird chronology census, potentially provide opportunity for outside research related to wildlife behavior in response to disturbance types and levels.
Objective A.c.4(a): Maintain a minimum of 60 percent of the refuge's wetland-habitat in sanctuary and other areas providing secure habitat, combined, such that (i) all life-history requirements of all major waterbird guilds are contained in the selected areas; (ii) a minimum of 4,000 acres are in sanctuary (no public access), and (iii) the "other secure areas" provide relatively secure feeding, resting, and breeding habitat for waterbirds.	Remote Sensing Distribution Census Time Activity Budget	Wetland and Riparian Habitats	Biannually map distribution of major wetland habitat types, Determine waterbird distribution among protected and unprotected areas, potentially provide opportunity for outside research related to wildlife behavior in response to disturbance types and levels.
Objective A.c4(b): Minimize human-disturbance to wildlife in areas outside the sanctuary while still providing opportunities for compatible wildlife-dependent recreation.	Public Use Monitoring Distribution Census Time Activity Budget	Upland, Wetland, Riparian, and sand dune habitats.	Determine for each activity, timing, frequency, and relative use level within different refuge habitat types. Correlate these activities with wildlife distributions collected for the waterbird chronology census, potentially provide opportunity for outside research related to wildlife behavior in response to disturbance types and levels.

Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Subgoal A.d: Fill information gaps with knowledge gained through monitoring, management studies, and research (including archaeological and paleoenvironmental investigations, and assessment of historical records), and assess the effectiveness of management actions and identify needed modifications to the management program.	Perform literature search from historic documentation to determine current level of understanding among biological communities, ecological processes, and historic functions. Where required, perform additional studies to obtain baseline information on poorly understood components.		
Objective A.d.1: Within five years, estimate the natural, relative level of abundance of all native species of fish and wildlife within Stillwater NWR (e.g., rare, accidental, uncommon, common, abundant), including natural variability over time.	Literature Search	All Native Wildlife Species	Where information exists, obtain estimates of native wildlife population levels, available life history information, and seasons of use for each species.
Objective A.d.2: Design management studies and modify the monitoring program, as needed, to ensure that major components of biodiversity, including key taxa of wildlife and vegetation diversity, are being adequately monitored and to evaluate the effectiveness of management actions undertaken by the Service.	Various Censuses Key Species Indicators	All native wildlife and vegetation communities	Develop flexible monitoring strategy, using indicator species approach to assess population/vegetation community dynamics in relation to our management actions. Assess effectiveness of monitoring strategies every five years.
Objective A.d.3: Design and implement baseline inventories of birds, amphibians, aquatic and terrestrial invertebrates (e.g., butterflies), and plants within three years along the lower Carson River and its delta, Stillwater Slough, Battleground Marsh, dunes, and nearby salt desert shrub areas to provide baseline information to assess the effects of habitat restoration efforts, including exclusion of cattle from riparian and upland areas.	Literature Search Various Censuses	Upland, Riparian, Wetland, and Sand Dune Habitats. Species where data are lacking.	Conduct literature search to determine which native species do not have sufficient data to assess response to management strategies. Design baseline inventory techniques to fill identified gaps.
Objective A.d.4: Estimate the natural geomorphology, hydrology, and habitat composition of the lower Carson River and the Battleground Marsh, in a way that recognizes natural year-to-year variations.	Literature Search Remote Sensing	Riparian and Wetland Habitats	Conduct literature search to identify historic processes and habitat compositions common to the Carson River and Battleground marsh. Biannually map habitat distribution.
Objective A.d.5: Estimate the natural composition, structure, and distribution of upland plant communities, and design and implement an inventory to determine the existing conditions of these parameters.	Literature Search Line Transect Quadrats	Upland Habitats	If possible, conduct literature search to determine natural structure and composition of upland plant communities. Establish permanent vegetation quadrats to monitor change in relation to our management actions.

Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Objective A.d.6: Assess whether the adopted sanctuary and other areas managed to provide security for waterbirds are of sufficient size and encompasses adequate breeding habitat for waterbirds, and feeding and loafing habitat for migrating and wintering waterfowl; and whether an adequate amount of secure habitat is provided in the walk-in only hunt area of Option C2.	Public Use Monitoring Distribution Census Time Activity Budget	Wetland and Riparian Habitats	Determine for each activity, timing, frequency, and relative use level within different refuge habitat types. Correlate these activities with wildlife distributions collected for the waterbird chronology census, potentially provide opportunity for outside research related to wildlife behavior in response to disturbance types and levels.
Objective A.d.7: Research ways to provide wetland-unit drawdowns during July-September in ways that mimic natural water-level declines and that accomplish habitat objectives, but do not contribute to significant avian botulism outbreaks (adapted from Nevada Partners in Flight Plan).	Existing Literature Remote Sensing Water Monitoring Disease Monitoring	Wetland Habitats	Determine the factors associated with botulism outbreaks at Stillwater NWR, identify units of concern based on past documentation, and develop water management strategies to minimize factor occurrence on identified wetlands units of concern.
Objective A.d.8: Investigate the habitat needs, especially nesting habitat, of snowy plovers.	Snowy Plover Census Outside Research	Playa Habitat Type	Continue annual census of snowy plover habitats to provide an index of relative population levels, provide opportunities for outside research to determine life history requirements while on the refuge.
Objective A.d.9: Participate in the comprehensive state-wide survey of potential nesting sites of black terns using professional and volunteer personnnel, as well as conduct an assessment of the role that Stillwater Marsh played in black tern ecology in the Great Basin (from Nevada Partners in Flight Plan).	Literature Search Distribution Census	Black Terns	Review existing literature to determine recent documentation (1959 to present) of black tern populations and nesting. Participate in state wide survey.
Objective A.d.10: Ascertain whether Nevada viceroys and Carson wandering skippers (butterflies) inhabit Stillwater NWR, and determine more precisely their habitat requirements.	Cruising Baseline Census Outside Research	Upland and Riparian Habitats	Use existing study to develop annual monitoring plan for important refuge butterfly species. Provide opportunity for outside researchers to collect life history information for these and other butterfly species.
Goal B: Contribute toward fulfilling obligations of international treaties and other international agreements with respect to fish and wildlife.			

Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Subgoal B.a: Prevent and abate pollution and detrimental alterations of native plants and animals including (1) preventing the introduction of nonnative plants and animals, (2) preventing the spread of introduced species that have become established, and (3) eradicate, to the extent possible, existing populations of nuisance species.	Continue to map through remote sensing, distribution of invasive species, use cruising to identify locations suitable for establishment of invasive species not currently present, and record treatments used and acres treated within existing invasive species dominated communities to determine relative success of control measures.		
Subgoal B.b: Restore, preserve, and conserve natural ecosystems and habitats for migratory birds, other animals, plants, other components of biodiversity, and for the protection and conservation of natural areas.	Use a combination of remote sensing, line transects, quadrats and wildlife population censusing techniques to determine relationships between wildlife and habitats, and relative proportion of non-native and native components within communities.		
Subgoal B.c: Ensure that public use does not detract from the Service's ability to achieve wildlife related refuge purposes and that it is consistent with conservation and sustainable use principles: and ensure that sufficient sanctuary is provided for waterfowl using the Lahontan Valley, which may require additional study.	NDOW Census Distribution Census Outside Research	Wetland and Riparian Habitat. All Waterfowl Species.	Determine relative abundance of waterfowl species utilizing all major wetland areas in the Lahontan Valley during fall/spring migration (NDOW). Determine the distribution of waterfowl species among sanctuary and public use areas in conjunction with chronology census. Provide opportunity and participate in proposal development for outside research project to assess waterbird security provided by pilot refuge public use options.
Subgoal B.d: Provide for the needs of migrating and breeding shorebirds as part of the Western Hemispheric Shorebird Reserve Network, in ways that are consistant with the approach prescribed under Goal A.	Continue annual monitoring programs to identify levels of utilization by common shorebird species. Develop specific monitoring protocol for collection of migration chronology and key species information.		
Objective B.d.1: Provide high-quality nesting and brood-rearing habitat for shorebirds and other waterbirds in consideration of habitat availability in other parts of the Lahontan Valley and throughout the Interior Basins ecoregion.	Remote Sensing Distribution Census	Upland, mud flat, and playa habitats. Key shorebird breeding species.	Biannually map the distribution of upland (adjacent to wetlands) and mudflat/playa habitats. Determine waterbird distribution among these habitats through annual ground census.

Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Objective B.d.2: Provide high-quality shorebird habitat during spring and fall migration, including rising water levels during spring and declining levels during the late summer and fall.	Remote Sensing Distribution Census	All shallow, lightly vegetated wetland habitats. Key shorebird migratory species.	Biannually map the distribution of upland (adjacent to wetlands) and mudflat/playa habitats. Determine waterbird distribution among these habitats in conjunction with waterbird migration chronology census.
Subgoal B.e: Provide high-quality habitat for migrating, breeding, and wintering waterfowl, to the extent that it does not measurably conflict with subgoals and objectives of Goal A.	In conjunction with the Nevada Division of Wildlife, continue collecting waterfowl population data during critical times of the year. Use habitat maps to estimate habitat availability for these populations.		
Objective B.e.1: Provide high-quality nesting and brood-rearing habitat for waterfowl and other waterbirds.	Remote Sensing Distribution Census	Upland, Wetland, and Riparian Habitats. All nesting waterfowl species.	Biannually map distribution of Wetland, Riparian, and upland habitats adjacent to wetlands. Conduct annual waterfowl pair count (NDOW) and brood surveys throughout wetland habitats. Assess upland nesting habitat quality through establishment of permanent vegetation quadrats.
Objective B.e.2: Provide high-quality wetland waterfowl-habitat during fall and winter, until wetland units ice over (generally late December or January).	Remote Sensing Distribution Census	Wetland and Riparian Habitats	Biannually map the distribution of all wetland habitats. Continue refuge-wide monthly waterfowl counts (NDOW). Compare migration chronology data with wetland unit habitat juxtaposition to index waterfowl distributions.
Objective B.e.3: Minimize the occurrence, spread, and severity of botulism and cholera outbreaks.	Botulism Monitoring	All waterbird species susceptible to botulism	Continue refuge wide botulism patrols to determine annual locations and mortality rates. Analyze these data to determine chronology of events and consistent "hot spots".
Objective B.e.4: Ensure that suitable wetland habitat is provided for other marsh dependent species, using white-faced ibis, black terns, American white pelicans, Clark's grebes, and short-eared owls as indicators.	Distribution Census Remote Sensing	Waterbird indicator species. Wetland habitats	Biannually map the distribution of wetland habitat types, particularly those of importance to wetland indicator species. Record indicator species numbers bimonthly in identified index wetlands. Compare annual counts with wetland habitat acreage to determine habitat/indicator species relationships over time.

Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Subgoal B.f: Provide high quality habitat for migrating and breeding birds in riparian areas and salt desert shrub communities in ways that are consistent with the overall approach prescribed under Goal A.	Using a combination of remote sensing, line transect, plot sampling, and point count methodology, annually index habitat quality and avian species response to document long term trends in habitat suitability for upland and riparian wildlife species.		
Objective B.f.1: Provide high quality habitat for neotropical migratory birds associated with riparian areas in ways that are consistent with the overall approach prescribed under Goal A, using yellow-billed cuckoos, ash throated flycatchers, blue grosbeaks, yellow breasted chats, and western bluebirds as indicator species.	Remote sensing line transects quadrats point count	Riparian habitats indicator species	Map distribution of riparian habitats every three years, and collect plant community and vegetative structure information from line transects and permanent quadrats annually. Record spring/fall abundance of identified riparian indicator species using point count methodology.
Objective B.f.2: Provide high quality habitat for birds associated with salt desert shrub areas in ways that are consistent with the overall approach prescribed under Goal A, using loggerhead shrikes and burrowing owls as indicator species.	Remote sensing line transects point count	Upland shrub habitats indicator species	Map distribution of upland habitats every five years, and collect plant community and vegetative structure information from line transects annually. Record spring/fall abundance of identified upland indicator species using point count methodology.
Subgoal B.g: Restore, enhance, and protect habitat for threatened and endangered species, species of special concern, and other sensitive, rare, or endemic species.	Perform literature search for key species to enrich our understanding of species specific habitat requirements. Develop monitoring protocol for each identified key species. Develop studies to determine if additional species require special protection (e.g., rare plant survey, amphibian surveys, etc...)		
Objective B.g.1: Within the next five years, reestablish, in a way favorable for future roosting by bald eagles (including a suitable distance from areas accessible to the public), cottonwood trees in the Timber Lakes area, and reestablish similar stands along other parts of the Carson river as additional lands are acquired.	Remote Sensing Vegetation Transects	Riparian Habitat, Bald Eagles	Annually map distribution of cottonwoods along riparian corridors. Conduct monthly Bald Eagle roost survey during winter, to determine annual population levels.
Objective B.g.2: During the interim until their habitat needs are better delineated, provide shallowly flooded, unvegetated playa habitat for snowy plover nesting in areas they have used in the past.	Remote Sensing Snowy Plover Census	Playa Habitat, Snowy Plover	Annually map the distribution of playa and open mud flat habitat throughout the refuge. Annually census the distribution of snowy plover among these habitats.

Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Objective B.g.3: Within the next five years, reestablish native willow and mesic shrub communities along the Carson River in the Timber Lakes area for the benefit of Nevada viceroys and other riparian shrub species of special concern, and reestablish such communities along other parts of the Carson River as additional lands are acquired along the Stillwater Slough.	Remote Sensing Cruising Vegetation Transects	Riparian Habitat, Riparian related invertebrate, bird, and amphibian species	Annually map the distribution of riparian habitats. Establish permanent quadrats to assess communtiy changes in response to management activities. Support quadrat information with line transects to cover a wider area of the riparian corridor. Adjust restoration techniques to incorporate new information on needs of riparian wildlife species.
Anaho Island NWR			
Goal A: Protect and perpetuate colonial-nesting birds and other migratory birds.	Monitor chronology, relative population levels, and nesting success for all colonially nesting species at Anaho Island, monthly throughout the breeding season. Annually band approximately 400 juvenile American white pelicans.		
Objective A.1: Provide a sufficient amount of nesting habitat, free from human disturbance and other threats, for colonial-nesting birds during the breeding season.	Remote Sensing Pyramid Lake LE	Colonies, all colonial nesting waterbirds	Annually map colony distribution on Anaho Island NWR. Consult with Pyramid lake tribal police to obtain citations issued for trespass violations to index relative levels of disturbance?
Objective A.2: Prevent the formation of a land bridge between Anaho Island and the eastern shoreline of Pyramid Lake.	Remote Sensing Lake Water Levels	Hydrology	Annually map the acreage and habitat types of Anaho Island NWR. Obtain Truckee river input amounts and annual water level from Pyramid Lake tribe.
Objective A.3: Closely monitor the breeding population of each colonial-nesting species (white pelicans, double-crested cormorants, gulls, herons, and egrets) to track the number of nesting pairs, hatchlings, and fledglings each year.	Ground Census	All colonial nesting species.	Through the breeding season, obtain monthly counts of nests, adults, and juveniles to allow for evaluation of chronological and breeding success trends.
Objective A.4: Promote research opportunities that would increase the Service's understanding of colonial-nesting birds, their life history requirements and potential contaminant problems.	Outside Research	All colonial nesting species.	Provide opportunity and participate in proposal development for outside research projects pertaining to colonial nesting waterbird life history information.
Goal B: Restore and maintain natural biological diversity.			

Goal	Broad Approach	Resources Monitored	Monitoring Procedures
Objective B.1: Restore and maintain a natural composition and structure of vegetation.	Literature Search Remote Sensing Vegetation Transects	All island vegetation types	Perform a literature search to estimate type and relative abundance of native habitats common to Anaho Island. Annually map the distribution of habitat types, and establish quadrats or line transects to assess change in community structure over time.
Objective B.2: Provide research opportunities that would enhance the effectiveness of restoring a natural composition and structure of vegetation, including research that explores the detrimental impacts of red brome, cheatgrass, and other invasive nonnative plants and possible ways to control these species.	Outside Research	Identified Native Vegetation Communities.	Provide and participate in proposal development for outside research projects pertaining to native vegetation community dynamics, vegetative species life history information, and/or exotic vegetation control.

Appendix 4: Development of refuge database manager to track fulfillment of CCP objectives outlined in Appendix 3.

Stillwater National Wildlife Refuge Complex Db Manager
Custom Software Solutions

Development of Database

Db Manager is written in Visual Basic for Applications (VBA) 6.0. VBA 6.0 is currently accepted by thousands of software developers due to its ability to be integrated into numerous PC applications currently on the market.

Db Manager uses Microsoft Office 2000 Professional Suite. This suite includes Access 9.0, Word 9.0, Excel 9.0, Powerpoint 9.0, and MS Graph 9.0. With the use of ActiveX Data Objects (ADO) and VBA 6.0 this suite is ready to meet tomorrow's needs for connectivity for Internet/Intranet applications.

Access 9.0 was chosen over numerous databases due to its powerful and robust 32-bit relational database management system (RDBMS). Db Manager is a client/server database application that will run under the current Intranet, which currently uses Windows NT 4+ as an operating platform. If the complex upgrades to future Windows NT platforms, Db Manager will continue to operate as written.

Access 9.0 is specifically designed for creating multiuser applications where database files are shared on networks. Access 9.0 also incorporates a sophisticated security system to prevent unauthorized persons from tampering with your data or the application.

Db Manager conforms with the generally accepted database design practice (GADBDP) to use separate .mdb files to contain data and application objects. Rcode contains all forms, reports, queries, macros and VBA 6.0 code. This database is compiled to prevent changes within the code. Rdata contains all tables which are linked to Rcode.

System Requirements

Db Manager currently is not a resource-intensive application. Db Manager was designed to operate on the slowest computer currently in use by the complex. Rcode, which is installed on the user side, requires a minimum of 16MB of free space. Rdata, installed on the server, requires much more free space. These items will be discussed in detail on the following pages.

System Design

Db Manger was designed to accomplish the following objectives:

- fulfill the needs of the complex for information in a timely, consistent and economical manner.
- minimize the duplication of content used by the complex.
- provide rapid access to specific elements of information required by each user.
- accommodate expansion to adapt to the needs of the complex.
- maintain the integrity of the database so that it contains only validated, audit able information.
- prevent access by unauthorized persons.
- permit access only to those elements of the database that individual users need in the course of their work.

Db Manager contains two databases which incorporate the front-end/back-end design. Rcode (front-end) contains all of the forms, pages, reports, graphs, queries and VBA code that is necessary to operate the application. This database is compiled to keep unauthorized changes being made to it. This also keeps the size needed on the desktop computer to a minimum. Rcode is currently 16.5MB however, this will grow with future demands of Db Manger.

Rdata (back-end) contains only tables which can be viewed by anyone with Access installed on their desktop computer. Rdata is linked to Rcode over the Intranet. Rdata is currently 20MB however, this will grow along with Rcode.

Rdata is linked to several .dbf files used by ArcView (GIS) application, spreadsheets, topo maps, satellite images, photographs and the Internet.

System Integration

Database: Maximum size of each database used can be 2.1 GB. This includes as many as 32,768 tables, forms, reports, queries, etc. As many as 1,024 tables can be open at any given time. This feature alone makes Access 9.0 an excellent choice.

You can import tables from other database applications such as dBASE, FoxPro and Paradox, Microsoft SQL Server and Microsoft Data Engine.

Spreadsheets: Microsoft Excel, Lotus 1-2-3.

Word Processing: Microsoft Word.

Statistical Applications: Any statistical software that can import/export ASCII text files.

GIS: ArcView 3.02a

Internet: IE 4.0 and higher

Database Hierarchy

Db Manager was built upon three principals of RDBMS design.: 1) is designed to deal efficiently with very large amounts of data; 2) to easily link two or more tables so that they appear to users as though they are one; 3) minimizes information duplication by requiring repetition of only those data items in which multiple tables are linked.

Rdata is the primary data table which currently contains; 1) Master Lookup Tables (MLT); 2) Primary Data Tables (PDT); Secondary Data Tables (SDT).

Master Lookup Tables consist of the following tables:

? User Information
? Unit Names
? Bird Species
? Class
? Cloud Cover
? Distance Cover
? Flow Gage Locations
? Habitat Zones
? Invertebrate Species
? Survey Type
? Vegetation
? Weather
? Plant Species Group
? Wind Speed
? Pyramid Lake Water Elevation
? Carnivore Species

Primary Data Tables consist of the following tables:

? Anaho Bird Survey
? Bag Checks
? Band Return
? Bird Survey
? Breeding Pair Survey
? Brood Survey
? Carnivore Survey
? Dead & Sick Survey
? Delivery System
? Flow Gage

- ? Nesting Survey
- ? Shorebird Survey
- ? Spadefoot Survey
- ? Spring Wings Participation
- ? Submergence
- ? Swan Survey
- ? Water Budget
- ? Waterfowl Survey
- ? Water Releases
- ? Weather

Secondary Data Tables consists of the following tables:

- ? Anaho Bird Data
- ? pbdPrimary
- ? sbdSecondary
- ? Carnivores Habitat
- ? Carnivore Plot
- ? Flow Gage Secondary
- ? Shorebird Data
- ? Submergence Data
- ? Water Budget Data
- ? Water Record Data

Db Manger relational design

The following example demonstrates the relational design of Db Manger and the storage techniques to minimize the size of the database.

The Carnivore survey requires the following information input by the observer.

Date of Survey: 10/15/01 **Observer:** Styron Bell

Habitat Type: Wetland **Location:** Willow Dike Road
Agriculture
Upland
Riparian

Plot number: W1, A1, U1, R1
W2, A2, U2, R2
W3, W3, U3, R3
Species: Coyote **Number of species:** 1

The following tables are used in the data entry and storing of data within Db Manager:

Date of Survey - Carnivore Survey (PDT)
Observer - User Information (MDT)
Habitat - Habitat Zone (MDT)
Plot number - Carnivore Plot (SDT)
Location - Unit Name (MDT)
Species - Carnivore Species (MDT)
# of species - Carnivore Plot (SDT)

If you were to look at the raw data within Db Manager it would appear as:

Carnivore Survey (PDT)

id	date
1	10/15/01

Carnivore Habitat (SDT)

id	hid	habitat
1	4	3

Carnivore Plot (SDT)

id	location	species	number of species
4	7	9	1
4	5	7	1

Currently the Carnivore Survey Data is stored in an Excel 9.0 spreadsheet that contains a total of 144 rows (79KB). Db Manager places this data into 3 tables:

(1) Carnivore Survey - 13 rows (1KB)
(2) Carnivore Habitat - 18 rows (2KB)
(3) Carnivore Plot - 23 rows (4KB)

Total of 54 rows (7KB)

Once Db Manager has been uploaded with existing data, the goal is to integrate Db Manger with ArcView 3.2. This will allow the user to click on a wetland unit and visually see what the data represents graphically. This will also provide a tool that the complex manager's may use to predict (based upon historical data) when and where to put water and most importantly... WHY!

Let's take a closer look at what Db Manager and ArcView can do for the user. South Nutgrass is a unit that is currently working (although some of the historical data is not accurate). The minimum pool elevation is at 3866' and maximum pool elevation is 3868'. These elevations has been established by an 1987 survey of the Stillwater National Wildlife Refuge. South Nutgrass has 4 inlets (inflows) and 2 outlets (outflows).

Using ArcView we can load satellite images that show current conditions on a given date. With this image we are able to see were the vegetation zone's lie. We are able to determine the volume of water currently within the unit.

Using the historical data stored in Db Manger we are able to pull into ArcView the following information: precipitation, evaporation, flow gage (inflows and outflows) readings, bird counts, and many other data as needed.

Using this information we can make the following informative decisions. When are the birds present, at what water level is most productive? How long will it take to raise the water elevation to gain the most productive vegetation zone for the birds, (taking into account inflow, outflow, precipitation and evaporation) . . . or maybe we should wait two weeks before we add more water? These are the typical decisions that the complex manager's must make every day. Once Db Manager is up and running, every user will be able to analyze this type of scenario on their desktop computer.

Appendix 5: Visitor Services Monitoring strategies

There is currently a proposal to develop a visitation monitoring program for the Service. This monitoring program is being developed because of the realization that budget allocations are directly tied to visitation; management issues arise when increased visitation begins to impact wildlife and resources; and that a standard method of assessment of visitation will increase integrity of reporting. Public use monitoring, when correlated with biological monitoring provides a basis for determining satisfactory levels of public use with minimum impact on wildlife and habitat. The proposal is being designed to:

"(1) Identify at least three standardized monitoring procedures appropriate to the different types of refuges and management units, and develop a written protocol for the application of each of these procedures.

(2) Develop a plan for the application of the standard monitoring procedures to every refuge and management unit in a timely fashion, in order to acquire data on the number of visitors."

This proposal further specifies that work will be completed by November 30, 2000.

In all current monitoring practices, (the best of those being used by the US Forest Service and the Army Corps of Engineers) there is one consistent theme. That is the use of remote sensing units to detect the movement of visitors, either road or infra-red counters (used to detect individuals on trails).

It is with the above explanation in mind, that Stillwater NWR will adopt the following methods to assess visitation in the assumption that the standard will be utilizing similar strategies.

Stillwater NWR presently employs the use of road counters, so in that light, is fairly up to recent technology. In all likelihood, any protocol developed by Dr. Davis will include the use of remote sensors. Stillwater NWR is also of a fairly simple layout to permit such a method to be used with some degree of accuracy, with only 3 access points open (Alternatives C and D).

A survey is currently underway to assess staff usage. It is assumed this percentage can change monthly or seasonally and is being assessed by staff members reporting for one week a month what road counters they traversed, and how often.

Volunteers (or staff when available) will perform visual observations to determine an average number of individuals per vehicle, as well as collect any incidental information that presents itself and found to be useful to the determination of numbers of visitors. An intensive survey is ongoing each hunting season since the '98-'99 season to determine hunter use, and if staff or volunteer time is available, a similar intensity will continue through the year. This vigorous survey is accomplished by assessing location and number of all the vehicles on the refuge, their location, and if possible, the activity and strategy of the visitor (whether using boat, dog, etc).

In the future, perhaps satellite technology can replace the use of staff time for gathering visitor logistics, but for the time being, visual observations are the best available science.

The surveys provide data that can be analyzed to assess density of recreationists. These densities will be used in correlation with biological monitoring efforts to attempt to ascertain the impacts associated with varying levels of activity.

A spreadsheet has been developed to interpret the data collected by the above methods. All the raw data is entered onto the sheet, and calculations are performed, using the extraneous information such as persons per vehicle and staff usage, giving an account that is as accurate as can possibly be developed. The spread sheets will show number of visits, not an assessment of visitor use days or visitor use hours. Additional information will need to be developed to make an assessment of a typical “use day”.

With the completion of a visitor’s center, head counts of all visitors will be made by docents manning the facility, and a count of all school and interpretive tours will be logged by staff/volunteers with actual group numbers.

The numbers derived from all the above mentioned sources will also provide information to be interpreted as to success of specific programs as well as simply numbers of visitors participating in the programs.

ENVIRONMENTAL CONTAMINANTS MONITORING PLAN
FOR
STILLWATER NATIONAL WILDLIFE REFUGE
CHURCHILL COUNTY, NEVADA

17 September 2001

by

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ENVIRONMENTAL CONTAMINANTS MONITORING PLAN FOR STILLWATER NATIONAL WILDLIFE REFUGE, CHURCHILL COUNTY, NEVADA

1. INTRODUCTION

The modification of wetland water supplies, natural hydrologic characteristics, and wetland processes in the lower Carson River basin have contributed to declines in habitat quantity, water and habitat quality, and the numbers and diversity of wetland-dependent fish and wildlife occurring in Stillwater Marsh and other wetlands in Lahontan Valley (Hoffman 1994, Tuttle et al. 2000). A number of environmental contaminants have been identified with these modifications and implicated as contributing to local ecological decline.

In 1990, Congress enacted the Truckee-Carson-Pyramid Lake Water Rights Settlement Act (Title II of Public Law 101-618; Act) to resolve conflicts associated with increasing water demands in the Truckee and Carson River basins. Section 206 of the Act authorized and directed the Secretary of the Interior, in conjunction with the State of Nevada and other parties, to acquire sufficient water and water rights to restore and maintain a long-term average of 25,000 acres of wetland habitat in Lahontan Valley of which approximately 14,000 acres would be restored on Stillwater National Wildlife Refuge (NWR). The Act also mandated that Stillwater NWR be managed for the purposes of:

1) maintaining and restoring natural biological diversity within the refuge;

2) providing for the conservation and management of fish and wildlife and their habitat within the refuge;

3) fulfilling the international treaty obligations of the United States with respect for fish and wildlife; and

4) providing opportunities for scientific research, environmental education, and fish and wildlife oriented recreation.

While the acquisition of water and water rights will expand the areal extent of Lahontan Valley wetlands, the long-term effect of water acquisition and increased inflow on wetland contamination are largely uncertain. Water acquisition is expected to, at least in part, mitigate effects of certain agricultural drainage-related contaminants. It is not, however, expected to reduce adverse effects associated with mercury. Conversely, some alternatives may exacerbate contamination. Therefore, management of Stillwater NWR to achieve the objectives of the Act will also require the management of environmental contaminants. As part of the Comprehensive Conservation Planning process, the U.S. Fish and Wildlife Service (Service) has identified goals for environmental contaminant concentrations for the water supply and wetland components of Stillwater NWR. Attainment of these goals will reduce the potential for environmental contaminants to directly affect fish, wildlife, and their habitat on Stillwater NWR and should increase the ability of the Service to fulfill statutory mandates for Stillwater NWR.

This environmental contaminants monitoring program is designed to assess concentrations, distribution, and biological availability of environmental contaminants on Stillwater NWR and to evaluate contaminant effects on fish, wildlife, and their habitat. The program represents a joint effort between staff of Stillwater NWR and the Nevada Fish and Wildlife Office (NFWO) of the Service. Monitoring data will be used to evaluate the effectiveness of water and habitat management practices in mitigating existing contamination and to track progress toward attaining environmental contaminant goals. This information will, in turn, be used to refine water and habitat management on Stillwater NWR. The monitoring program is largely modeled after the Lahontan Valley environmental contaminants monitoring study conducted under the National Irrigation Water Quality Program (NIWQP) from 1994 to 1996 (Tuttle et al. 2000). Data generated by that study may serve as a baseline against which to evaluate changes in wetland characteristics and contaminant levels. The environmental contaminants monitoring program is also designed to accompany biological monitoring on the refuge. In this manner, the overall cost of monitoring may be reduced while the interrelation of contaminants and species composition, habitat quality, and biological processes on Stillwater NWR may be evaluated more comprehensively.

2. BACKGROUND

Elevated concentrations of several environmental contaminants have been identified on Stillwater NWR and other wetlands in Lahontan Valley. The primary concerns are related to agricultural development and anthropogenic mercury; other contaminant sources have also been identified.

The modification of wetland water supplies, natural hydrologic characteristics, and wetland processes resulting from agricultural development have contributed to declines in habitat quantity, water and habitat quality, and the numbers of wetland-dependent fish and wildlife occurring in Stillwater Marsh and other wetlands in Lahontan Valley (Kerley et al. 1993). Following regulation of the lower Carson River, inflow of relatively good quality water directly from the Carson River was reduced and drainage from agricultural areas became an increasingly larger component of the wetland water supply. Drainage from agricultural areas, including operational spills, surface runoff from fields, and subsurface drainage, commonly contains elevated concentrations of dissolved solids, including a variety of major and trace elements, which have been mobilized from soils or local groundwater. The discharge of irrigation drainage to wetlands has contributed to substantial changes in the biogeochemical cycling of major and trace constituents in the wetlands (Lemly et al. 1993). Increased irrigation efficiencies mandated under the Operational Criteria and Procedures in the 1970's further reduced the inflow of fresh water since 1970 (Hoffman 1994). Dependence on drainwater resulted in a shift in water delivery patterns to wetlands, with inflows to wetlands corresponding to the release of irrigation water from Lahontan Reservoir over the irrigation season. Reduced inflow of water resulted in the hydrologic isolation of some wetlands while diking and flow regulation within the wetlands disrupted the flow-through character and increased the hydrologic retention time of other wetlands. Such changes reduced the frequency and efficiency of flushing of dissolved solids through the wetlands. The high rate of evaporative water loss in this hydrologically isolated basin has contributed to accumulation and concentration of dissolved constituents in wetlands (Seiler 1995).

Hoffman et al. (1990) found that water in Stillwater NWR contained concentrations of arsenic, boron, dissolved solids, sodium, and un-ionized ammonia in excess of baseline conditions or Federal and State criteria for the protection of aquatic life or the propagation of wildlife. Sediment from some affected wetlands contained elevated levels of arsenic, lithium, mercury, molybdenum, and zinc. Additionally, concentrations of arsenic, boron, copper, mercury, selenium, and zinc in tissues from organisms collected from some affected wetlands exceeded levels associated with adverse biological effects in other studies. Organochlorine compounds were detected in sediments collected from wetlands of Stillwater NWR. Of greatest concern was lindane which, in normalized concentrations, exceeded the Environmental Protection Agency's (EPA) sediment quality criteria in three samples. This study concluded that arsenic, boron, mercury, and selenium were of primary concern to human health and fish and wildlife in and near Stillwater NWR. Subsequent studies have generally supported these findings (Lico 1992, Hallock and Hallock 1993, Tuttle et al. 1996, Tuttle et al. 2000). The magnitude of long-term adverse effects at population- and community-levels are difficult to discern because quantitative historical data on wetland communities in Lahontan Valley are largely lacking. However, wetlands on Stillwater NWR exhibit several characteristics of an impaired ecosystem, including reduced species diversity, community dominance by a small number of aquatic taxa, and the predominance of pollutant-tolerant fish and aquatic invertebrate species (Tuttle et al. 2000). Water in certain drains entering Stillwater NWR was found to be toxic to aquatic invertebrates and fish larvae. Toxicity was not attributed to a single element, but appeared to be related to a mixture of dissolved constituents, including arsenic, boron, lithium, molybdenum, and total dissolved solids (Finger et al. 1993).

Currently, mercury appears to represent the greatest hazard to wetland species in Lahontan Valley. Mercury contamination in Lahontan Valley resulted from the release of elemental mercury during precious metal milling which occurred in and near the Virginia Range from about 1860 to 1900. Mercury released during these operations was subsequently transported to Lahontan Valley via the Carson River. Recent transport has been found to occur primarily in particulate form (Bonzongo et al. 1994, Hoffman and Taylor 1998). Concentrations in sediment frequently have exceed levels associated with adverse effects to aquatic invertebrates and mercury in sediment has been correlated with adverse effects to aquatic invertebrate community structure (Tuttle et al. 2000). The availability of mercury appeared to be controlled by methylmercury in sediment (Tuttle et al. 2001). Availability of mercury was greater in constructed wetlands despite having lower total mercury concentrations in sediment. Mercury concentrations in a majority of fish and invertebrate samples and a smaller number of aquatic vegetation samples exceeded dietary concentrations associated with adverse behavioral effects in avian species. Concentrations in a large number of these samples also exceeded those associated with histopathology and reproductive effects in birds. Mercury was transferred to higher trophic levels and mercury concentrations in a large number of the avian eggs and juvenile livers exceeded concentrations associated with behavioral effects in birds. Concentrations in a smaller number of these samples exceeded those associated with histopathology and reduced survival. The correlation of mercury in sediment with mercury in pondweed and invertebrates suggests that food chain contamination originates from sediment. Although correlations were not significant, mercury concentrations in avian eggs and juvenile livers were generally higher in wetlands with higher concentrations of mercury in sediment. Because sediments act as both a sink and a source of mercury in aquatic systems, the acquisition of water authorized under P.L. 101-618 is unlikely to mitigate mercury contamination.

While pesticides, especially herbicides, are commonly used on the Newlands Project, information on pesticide concentrations in water delivery canals and drains is sparse. One investigation detected pesticides in the majority of water samples collected from agricultural drains (Lico and Pennington 1997). The herbicides atrazine, simazine, and prometon were most frequently detected. Concentrations were less than levels associated with acute mortality. This investigation was conducted in August, when heavy use of herbicides would not be expected. The aquatic herbicide, Acrolein, is used to control submergent and emergent vegetation in Newlands Project water delivery canals. Although this herbicide is highly toxic to aquatic organisms, it is not persistent in aquatic systems. Truckee-Carson Irrigation District (TCID) has indicated that Acrolein is only applied to waters delivered to agricultural fields, and not to water delivered to wetlands. It is uncertain if Acrolein enters Stillwater NWR in supply water through direct or indirect routes.

Sewage effluent, urban runoff, and runoff from confined animal feeding operations have been identified as potential sources of contamination to Stillwater NWR. Sewage effluent is a significant source of nutrients, especially nitrogen and phosphorus, dissolved constituents (calcium, sodium, magnesium, iron, and sulfur), suspended solids, pathogens, and endocrine disrupting chemicals in aquatic systems (Purdom et al. 1994, Flomar et al. 1996, Metcalfe et al. 2001). The City of Fallon, Fallon Naval Air Station, and a private sewage treatment facility are permitted to discharge treated sewage effluent to drains entering Stillwater NWR. Additionally, seepage from domestic septic systems is believed to enter agricultural drains. Agricultural drains in and near Fallon are currently used to convey urban runoff. Although not investigated in this area, urban runoff commonly contains a variety of petroleum products, polycyclic aromatic hydrocarbons, pesticides, and metals. An unknown number of confined animal feeding operations are located near or adjacent to drains entering Stillwater NWR. Confined animal feed lots are recognized sources of nutrients, pathogens, trace elements, pharmaceuticals, and endocrine disrupting chemicals.

3. MONITORING PARAMETERS, LOCATIONS, AND FREQUENCY

A wide variety of contaminants have the potential to adversely affect fish and wildlife on Stillwater NWR. The toxicity and nature of effects of these contaminants to fish and wildlife vary with chemical, environmental condition, organism, and exposure pathway. Therefore, effective monitoring requires the determination of contaminants in several environmental media and the assessment of effects at organismal, population, community, or ecosystem levels. Monitoring objectives include characterization of the quality of water delivered to the refuge and changes in water quality in wetland units, characterization of contaminant exposure and accumulation in environmental media, and characterization of effects to fish, wildlife, and their habitats.

3.1. Water Supply Monitoring

Wetland habitat quality and community composition are determined, in part, by water quantity and quality. Water also acts as the primary transport and exposure pathways for contaminants of concern on Stillwater NWR. As such, water deliveries may be used as a tool to attain biological and environmental contaminant goals for Stillwater NWR.

3.1.1. Water Quantity

Flow measurement is critical to characterizing contaminant transport to the refuge and quantifying contaminant loads entering the refuge via various delivery routes. Therefore, detailed accounting of water volumes delivered to the refuge is recommended. Flow quantity should be monitored on the four primary water delivery routes to Stillwater NWR (i.e., S-Line Canal, D-Line Canal, Diagonal Drain, and the Carson River downstream from Sagouspi Dam). To the extent possible, existing monitoring data generated by the U.S. Geological Survey (USGS) should be utilized. USGS continuously monitors flow at these locations (USGS Stations 1031221902, 10312277, 10312210, and 10312275, respectively). Where possible, flow information for other potential refuge inflows (e.g., Stillwater Slough and Canvasback Gun Club) should be obtained from TCID. Where continuous gaging of drains and canals contributing significant inflow is lacking, flow volume should be estimated regularly (i.e., every other week) when these facilities are active. If possible, weirs should be installed to enable rapid flow volume estimation.

3.1.2. Field Measurement of Water Quality Parameters

An understanding of water quality conditions is needed to adequately interpret chemical and biological data. Therefore, temperature, dissolved oxygen, pH, specific conductance, and turbidity of primary water sources entering the refuge should be monitored. Where possible, existing continuous recording gages (e.g, specific conductance recording at USGS gages) should be used. The USGS continuously monitors specific conductance in three water delivery routes to Stillwater NWR (S-Line Canal, Diagonal Drain, and D-Line Canal). In the absence of such gages, water quality parameters should be measured on a regular basis (i.e., minimum of every other week) at flow monitoring gages or at selected locations where flow volume is measured. Protocol for measurement of water quality parameters is provided in Section 4.

3.1.3. Water Quality Monitoring

To assess the transport of contaminants to Stillwater NWR, the chemical quality of inflow water in the four major water supply routes (S-Line Canal, Diagonal Drain, D-Line Canal, and the Carson River downstream from Sagouspi Dam) should be monitored quarterly. Sampling should be coordinated with USGS and Nevada Division of Environmental Protection to prevent duplication of effort. Water samples should be collected for analysis of total dissolved solids, major ions, nutrients, suspended solids, trace elements, and bacteria (i.e., fecal coliform and *E. coli*). Recommendations for water monitoring locations and frequency are presented in Table 1.

Table 1. Annual analytical requirements (number of samples) for water quality monitoring as part of the Stillwater National Wildlife Refuge Contaminants Monitoring Program. “a” denotes as needed.

site	TDS	major ions	nutrients	suspended solids	trace elements	bacteria	mercury	pesticides	Acrolein
D-Line Canal *	4	4	4	4	4	4	4	3	5
S-Line Canal *	4	4	4	4	4	4	4	3	5
Diagonal Drain *	4	4	4	4	4	4	4	3	5
Carson River *	4	4	4	4	4	4	4	3	5
minor inflows	a	a	a	4	a	a	a	a	a
flood events	-	-	-	45	-	-	45	-	-
selected wetlands	12	12	-	-	12	-	12	-	-
duplicate samples	3	3	2	6	3	2	7	1	2
trip blanks	-	-	-	-	2	-	5	1	1

* Methyl mercury will also be analyzed quarterly at these sites. One equipment blank (see text) for trace elements will also be included.

Water should not be filtered at the time of collection so that total chemical loads entering Stillwater NWR can be calculated. Water samples may be analyzed by USGS. As an alternative, a local laboratory would be used for analysis of total dissolved solids, major ions, nutrients, suspended solids, and bacteria, and a Service contract laboratory would be used for trace element analyses. Protocols for sample collection and handling are presented in Section 4. Water temperature, specific conductance, pH, and turbidity should be measured in the field using appropriate instruments at the time of water sample collections.

The volume of water, contaminant concentrations, and contaminant loads delivered through each of the primary water supply routes should be reviewed annually. Where possible, delivery routes supplying the lowest contaminant loads proportional to the volume of water delivered should be used for subsequent water deliveries. Conversely, the use of routes supplying high contaminant concentrations or high contaminant loads proportional to water volume should not be used. If the use of water delivery routes supplying high contaminant loads is unavoidable, as in the case of certain agricultural drains, water may be routed to tertiary (i.e., furthest downstream) wetlands. Routing water in this manner will help protect the integrity of the highest quality water.

The quality of unmonitored minor inflows (e.g., inflow from the Canvasback Gun Club) should be characterized during the 3 years of implementation of the monitoring program or when the sources are initially identified. Characterization should include estimation of flow volume and determination of total dissolved solids, major ion, nutrient, trace element, and bacteria concentrations, and field measurement of water quality parameters. If no significant contaminant concerns are identified, field measurements of water quality parameters should be monitored monthly. Additional water samples for contaminant determinations should be collected if significant adverse changes in water quality parameters are observed. When significant adverse changes in water quality are observed, measures to reduce or eliminate the minor inflow should be considered.

3.1.4. Mercury

Mercury currently represents the greatest contaminant threat to Stillwater NWR (Tuttle et al. 2000). Large loads of mercury enter the refuge via wetland water supply. Mercury loads vary among surface water inflows. Total and methyl mercury concentrations in primary water delivery routes should be analyzed quarterly (when flowing). Data on mercury concentrations and loads in water supply should be reviewed annually. Routes supplying water with elevated mercury concentrations or disproportionately high contaminant loads should be avoided. In certain cases, such as D-Line canal, dredging of surficial sediment in the canal may reduce mercury concentrations in the water column.

Large loads of mercury may be mobilized and transported during and following flood events in the Carson River Basin (Hoffman and Taylor 1998). Therefore, while flood events may provide an opportunity to flush or otherwise dilute dissolved solids in wetlands, the use of flood waters for wetland management has the potential to exacerbate mercury contamination on Stillwater NWR. More information is needed to characterize the benefits and risks of using flood waters in wetlands. To generate such information, water quality parameters, suspended solids, total mercury concentrations in unfiltered water, and stream flows should be monitored in Lahontan Reservoir and the four primary water delivery routes during flood events. Data and samples should be collected at 24-hour intervals during and for a 5-day period following the flood event and at weekly intervals (4 weeks duration) following flood subsidence. Data generated through this monitoring component should be used to calculate mercury loads in various stages of the flood and to identify water quality parameters (i.e., changes in turbidity, specific conductance, etc.) which may be used as indicators of marked changes in mercury concentrations. Such information could be used to obtain beneficial uses of flood waters without compromising the integrity of the wetlands.

3.1.5. Pesticides

Because cursory sampling identified pesticides in refuge supply water, a comprehensive evaluation of pesticide transport to Stillwater NWR is warranted. To minimize cost of pesticide monitoring, an evaluation of pesticide use (including Acrolein) in agricultural areas should be conducted to identify pesticides used in significant quantities. Pesticides should be monitored on three occasions during periods of peak pesticide application. Water samples for pesticide scans should be collected from the four primary water delivery routes to Stillwater NWR. Samples should be analyzed for high-use pesticides. The collection, handling, and storage of water samples for pesticide analyses should adhere to protocols provided by the analytical laboratory. If sampling indicates that pesticide concentrations are below levels of concern, pesticide monitoring may be discontinued. If concentrations exceed levels of concern, refuge and NFWO staff should work with the pesticide users, applicators, and the University of Nevada Agricultural Extension Office to develop application and use methods that would reduce the potential for pesticides to enter surface waters or otherwise be transported to the refuge.

Acrolein, an aquatic herbicide used to control vegetation in irrigation water canals, is used in the Newlands Project. Acrolein is highly toxic to aquatic organisms and, therefore, should not enter Stillwater NWR. Acrolein should be monitored in the primary water delivery routes to Stillwater NWR. Monitoring should be coordinated with the TCID. Water samples for Acrolein analysis should be collected from affected water delivery canals and potentially affected drains prior to and at 24 hour intervals for 4 days following Acrolein treatment. If Acrolein is not detected, sampling may be discontinued. If Acrolein is detected, refuge and NFWO staff should work with TCID to develop management measures to prevent Acrolein from entering wetlands or develop other alternatives to control aquatic vegetation in canals.

3.2. Wetland Water Quality Monitoring

The attainment of biological goals and objectives for Stillwater NWR will require the effective management of dissolved solids in wetlands. Because of the close association of dissolved solids concentrations and concentrations of certain contaminants (i.e., boron, arsenic, and molybdenum), reducing concerns with dissolved solids will also reduce concerns with these contaminants. Additionally, information on the associations among water quality variables and habitat and community characteristics is needed to increase the ability of refuge managers to attain biological objectives. Monitoring of water quality on the refuge will provide information needed to accomplish these tasks.

Monitoring should include the assessment of the volumes and quality of water delivered to specific wetlands. Ideally, continuous monitoring gages should be used to monitor flow volumes in major delivery canals. In the absence of gages, flows should be visually monitored at a frequency which would enable an accurate estimation of volume. Because of the strong correlation of specific conductance and dissolved solid concentration, specific conductance may be used to accurately estimate dissolved solids concentrations and to calculate dissolved solids loads. Specific conductance should be monitored at least weekly in water delivery canals. The volume and specific conductance of water moved between wetlands should be monitored at frequencies enabling the accurate estimation of dissolved solids loads. Water quality parameters and elevations of major wetlands on Stillwater NWR should be monitored monthly.

Total dissolved solids, major ions, trace element, total mercury, and methylmercury concentrations should be monitored in water in six representative wetlands semi-annually (Spring and Fall). Stillwater Point Reservoir, Dry Lake, East Alkali Lake, Lead Lake, Swan Check, and Pintail Bay are recommended based on their location in the wetland complex and the existence (in most cases) of previous water quality data. Protocols for sample collection and handling are provided in Section 4. Water temperature, specific conductance, pH, and turbidity should be measured in the field using appropriate instruments at the time of water sample collections.

A dissolved solids mass balance model would serve as an effective tool for planning and wetland management on Stillwater NWR. Currently, the Service is refining a model to assist in the management of water volumes on Stillwater NWR. This model should be expanded to include dissolved solids concentrations and loads. Information gained from wetlands water quality monitoring should be used for the development of the model. Ultimately, the model would assist refuge managers in the control of dissolved solids and water-soluble contaminant concerns on Stillwater NWR.

3.3. Wetland Contaminant Sampling

Previous investigations identified elevated concentrations of several trace elements in water, sediment, and biological tissues collected from Stillwater NWR wetlands. In several instances, concentrations exceeded levels associated with adverse biological effects and environmental contaminant goals for Stillwater NWR. The Service and the NIWQP have previously monitored contaminant concentrations in water, sediment, and biological tissues on Stillwater NWR (Tuttle et al. 1996, Tuttle et al. 2000, Tuttle et al. 2001). As a result of these efforts, comprehensive baseline information has been established for Dry Lake, Lead Lake, and Stillwater Point Reservoir. Less comprehensive information is also available for Swan Check and East Alkali Lake.

Monitoring of trace element concentrations in water, sediment, and biological tissues from Stillwater NWR wetlands should continue on a periodic basis. At this time the collection of comprehensive monitoring data is recommended once every 3 years. Six wetlands are recommended for monitoring to account for differences in wetland form and differences in mercury concentrations between the western side of the refuge (e.g., historical wetlands) and the eastern side (e.g., constructed wetlands). Because of the existing baselines, Stillwater Point Reservoir, Dry Lake, East Alkali Lake, Lead Lake, Swan Check, and Pintail Bay are recommended as monitoring wetlands.

Monitoring of trace element concentrations in multiple sample matrices is recommended to ensure that potential exposure pathways and end points of concern are represented in the program. Monitored matrices should include water, sediment, representative food chain organisms, avian eggs, and livers from pre-flighted juvenile birds. Three food chain organisms, aquatic vegetation (pondweed), aquatic invertebrates (corixids), and fish (juvenile carp), are recommended to represent potential exposure to principle avian trophic guilds. Monitoring of both aquatic vegetation and invertebrates is further recommended because past monitoring has demonstrated that concentrations of trace elements of concern vary in these food chain organisms (e.g., aluminum and boron are elevated in aquatic vegetation, whereas mercury and selenium are elevated in aquatic invertebrates). Fish should be collected to assess contaminant risk to piscivorous (i.e., fish eating) species. If risk to piscivorous birds is determined to be inordinately high, measures to control fish production in certain wetlands may be warranted. Monitoring of trace element concentrations in avian eggs is recommended to indicate the potential for trace elements to affect hatching success and survival of juveniles or otherwise affect avian production. Monitoring of trace element residues in livers of pre-flighted juvenile birds is recommended to provide an indication of contaminant exposure in specific wetlands. Monitoring of eggs and juvenile birds representing the two dominant trophic guilds is preferred. However, sampling of a single avian species will reduce costs. Past monitoring has demonstrated that trace element residues in livers of juvenile American coots (a herbivorous species) and eggs of this species were generally consistent with concentrations in American avocet (an insectivorous species). Therefore, monitoring of coots, which are more abundant and widespread on the refuge, is recommended.

Based on concentration variance in past monitoring results, the collection of one water sample, three samples each of sediment, aquatic vegetation, aquatic invertebrates and fish, and five samples each of avian eggs and avian livers from each wetland is recommended (Table 2).

For consistency with past monitoring efforts, avian eggs should be collected in May and other sample matrices should be collected in June and July. Permanent sampling stations should be established within selected monitoring wetlands. Water, sediment, vegetation, invertebrate, and fish samples should be collected within a 50-m radius of a central point. Avian eggs and juveniles should be collected as near as possible to the established sampling point. All samples should be submitted to an appropriate Service laboratory or its contract laboratory for trace element analyses. Sample collection and handling are discussed in Section 4.

Table 2. Locations for wetland contaminant sampling and types of samples to be collected for trace element analyses as part of the Stillwater National Wildlife Refuge Contaminants Monitoring Program. Samples should be collected once every 3 years.

site	water	sediment	pond-weed	corixid	fish	coot egg	coot liver
Stillwater Point Res.	1	3	3	3	3	5	5
Dry Lake	1	3	3	3	3	5	5
East Alkali Lake	1	3	3	3	3	5	5
Lead Lake	1	3	3	3	3	5	5
Swan Check	1	3	3	3	3	5	5
Pintail Bay	1	3	3	3	3	5	5
Duplicates	1	2	2	2	-	-	-
Equipment Blanks	2	-	-	-	-	-	-

Temperature, dissolved oxygen, pH, specific conductance, and turbidity should be measured in the field using appropriate instruments at the time of water sample collections. Water quality parameter measurements, information on collection conditions, and notes on deviation from methodologies should be recorded on data forms (Appendix A).

3.4. Toxicity Testing

Previous studies have demonstrated that water collected from certain drains and certain wetlands on Stillwater NWR was toxic to fish larvae and invertebrates (Ingersoll et al. 1992, Dwyer et al. 1992, Finger et al. 1993). Mortality occurred over a broad range of specific conductance and, in certain instances, mortality was not related to specific conductance or concentration of any single constituent. These results indicate that water quality monitoring may not always provide an accurate indicator of the potential of agricultural drain water to adversely affect fish and wildlife. Therefore, assessment of the toxicity of Stillwater NWR supply water should be incorporated into the monitoring program. Initially, toxicity testing should be used to screen principal refuge inflows and water in representative wetlands. Toxicity testing should be conducted in conjunction with quarterly monitoring of supply water quality. If toxicity is not identified, the frequency of testing should be reduced to annually. If significant toxicity is identified, implementation of a more comprehensive toxicity testing program may be warranted.

3.5. Fish Condition Assessment

Fish condition may provide an indication of environmental stress, including exposure to environmental contaminants. Environmental stress can affect growth rate and general condition of fish. Condition factors, such as Fulton's condition factor, provide a relative measure of the condition of individual fish and populations (Anderson and Gutreuter 1983). Such factors may also be used to compare relative condition of populations and to monitor environmental change over time (Ney 1993). Additionally, a variety of environmental contaminants may elicit teratogenic effects in offspring or promote disease or infection. Assessment of general condition and teratogenic deformities in fish may provide indicators of contaminant exposure and effects. Results of fish condition assessments should be evaluated against results of environmental contaminant analyses. If a high incidence of abnormalities is observed at any location, a more detailed assessment of environmental conditions and contaminant concentrations should be initiated.

3.6. Assessment of Indicators of Endocrine Disruption

Several studies have associated endocrine disruption with the discharge of treated sewage effluent (Purdom et al. 1994, Flomar et al. 1996, Metcalfe et al. 2001). An endocrine disruptor, has been defined as "an exogenous chemical substance or mixture that alters the structure or function(s) of the endocrine system and causes adverse effects at the level of the organism, its progeny, populations, or subpopulations of organisms ..." (EPA 1997). The mode of action of endocrine disrupting chemicals (EDC) may include interference with the synthesis, secretion, transport, binding, or elimination of natural hormones in the body. In this manner, EDC have the potential to compromise normal reproduction, development, growth, and homeostasis. Known EDC include a variety of pesticides, industrial compounds, and pharmaceuticals and personal care products (PPCP). An increasing number of studies have linked the occurrence of EDC in the environment with biochemical and physiological changes and a variety of behavioral, reproductive, developmental, and immune system effects in invertebrates, fish, amphibians, reptiles, birds, and mammals (EPA 1997). Effects are often subtle, but occur at extremely low concentrations (Daughton and Ternes 1999).

Three sewage treatment plants are permitted to discharge treated sewage effluent to drains entering Stillwater NWR. Additionally, seepage from septic systems located throughout Lahontan Valley may enter Lahontan Valley wetlands. Therefore, assessment of endocrine disruption is warranted. Initially, evaluation of the potential for endocrine disruption on Stillwater NWR should focus on the determination of hormone concentrations and ratios and vitellogenin in fish collected from primary water delivery routes to Stillwater NWR. If concerns are identified, assessment should be expanded to include determination of hormone and vitellogenin concentrations in fish and birds collected from wetlands receiving inflow from the primary water delivery systems.

3.7. Aquatic Community Assessment

Degraded water quality, chronic exposure to environmental contaminants, and other forms of environmental stress can affect aquatic invertebrate and fish community structure (Plafkin et al. 1989, Landis and Yu 1995). Assessment of aquatic community characteristics provides a means to monitor changes in ecosystem stress over time (Newman, 1995). Such information would provide a useful tool to gage the success of water and habitat management on Stillwater NWR. Community condition assessment would also provide a mechanism to better understand the interrelation of water quality, environmental contaminants, and biological characteristics and processes on Stillwater NWR. Therefore, aquatic community assessment should be incorporated into the Stillwater NWR monitoring program. This assessment should include aquatic invertebrate and fishery monitoring and application of community structure indices for invertebrates and fish (Plafkin et al. 1989). Previous monitoring efforts under NIWQP (Tuttle et al. 2000) adapted methodologies recommended by Miller et al.(1988), Plafkin et al. (1989), and Newman (1995). This information may serve as a baseline for future assessments on Stillwater NWR.

4. MONITORING METHODS AND PROCEDURES

4.1. Personal Protective Equipment

Latex gloves and hip boots or chest waders should be used during the collection and processing of all samples for contaminant analysis to prevent exposure of the sampler to potentially toxic constituents and to avoid inadvertent contamination of samples.

4.2. Measurement of Water Quality Parameters

Water quality parameters should be determined with suitable water quality meters (i.e., Hydrolab or Yellow Spring Instruments). Meter operation should follow manufacturers specifications. Parameters should only be measured in undisturbed water. Meters should be maintained and calibrated as specified by the manufacturer prior to use at each site. Water quality parameter measurements, information on collection conditions, and notes on deviation from methodologies should be recorded on data forms (Appendix A).

4.3. Analytical Sample Collection

Coordination with analytical laboratories for specific analyses should be conducted prior to field collections. Sample collection and handling should adhere to protocols (container types and sizes, field processing, handling procedures, etc.) specified by the appropriate analytical laboratory. In many instances (e.g., TDS, major ions, suspended solids, and bacteria analyses) sample containers for water should be provided by the laboratory. Samples for trace element analyses should be collected directly into appropriate containers (e.g., 250 or 500 ml nalgene bottles). Glass containers with teflon-lined closures should be used for water samples for analysis of pesticides and other organic contaminants. All water samples should be submitted to the pre-arranged analytical laboratory within the hold time specified by the analytical laboratory. Trace elements that should be analyzed; recommended detection limits are provided in Table 3.

In flowing water, unfiltered water samples should be collected from mid-stream from mid-water column depth while facing in an upstream direction. Samples should be collected by immersing a closed certified cleaned bottle of appropriate volume and then opening it under water. Each sample bottle should be rinsed three times using the above collection technique prior to collection of the sample. Rinsate should be disposed of down stream of the sample collection site. In non-flowing water, water samples should be collected from undisturbed areas. Rinsate should be disposed of away from the sample collection site. Individual samples should be processed as specified by the analytical laboratory (e.g., acidification of samples for trace element analyses). Samples should be stored on ice immediately and delivered to the analytical laboratory within the specified time frame. Water samples should be refrigerated if they are retained for a period exceeding 24-hours. For quality assurance/quality control (QA/QC) purposes, duplicate samples and field blanks should be collected and submitted for specified chemical analyses (Table 1). Field blanks should consist of deionized water exposed to sample collection and processing conditions. These duplicates and blanks should be treated as individual samples and submitted for metal and trace element analysis.

Sediment samples should be collected using an appropriate sediment coring device. Each sediment sample should consist of composites of the top 3-cm of five individual sediment cores. Sediment composites should be thoroughly mixed within a nalgene or stainless steel container. A sub-sample (minimum of 50 grams) should be retained for analysis. Pondweed (*Potamogeton* spp.) samples should be collected by hand and rinsed with site water to remove loosely adhered debris. Water boatmen (*Corisella* spp.; corixid) samples should be collected with a kick net and sorted from debris in the field. Past sampling efforts found that minnow traps and trap nets were most effective at fish capture within Stillwater NWR wetlands. Nets or traps should be set overnight (Tuttle et al. 2000). Vegetation and invertebrate samples should consist of composites of a minimum of 15 grams of material. Fish samples should consist of composites of five fish. Sediment, vegetation, and invertebrate samples should be placed in appropriate containers (e.g., certified clean glass jars with a teflon-lined closures) following field processing, stored on ice in the field, and frozen upon return to the office. Avian eggs should be collected by hand, placed in chemically cleaned jars, stored on ice in the field, and later opened using pre-cleaned stainless steel instruments in the laboratory. Embryos should be inspected for gross abnormalities and egg contents should be placed in 60 ml acid-washed glass containers, then frozen. Juvenile birds should be placed in plastic bags in the field, stored on ice, and processed upon return to the laboratory. Juvenile American coots should be collected using a shotgun with steel shot. Whole livers should be removed with pre-cleaned stainless steel instruments in the laboratory. Whole livers should be placed in 60 ml acid-washed glass containers, then frozen. Samples should be submitted to the Patuxent Analytical Control facility or one of its contract laboratories for trace element scans. Trace elements and their recommended detection limits are provided in Table 3.

Table 3. Analytes and detection limits recommended for trace element analyses for the Environmental Contaminants Monitoring Plan for Stillwater National Wildlife Refuge.

analyte	water (µg/L, wet weight)	sediment (µg/g, dry weight)	tissue (µg/g, dry weight)
aluminum	50	10	5.0
arsenic	5.0	0.5	0.50
boron	100	10	2.0
barium	5.0	1.0	1.0
beryllium	0.5	0.2	0.1
cadmium	0.5	0.2	0.1
chromium	3.0	1.0	0.5
copper	5.0	1.0	0.5
iron	100	10	5.0
lead	5.0	5.0	0.5
magnesium	100	10	5.0
manganese	5.0	5.0	1.0
mercury	0.01	0.01	0.01
molybdenum	10	5.0	2.0
nickel	5.0	5.0	0.5
selenium	1.0	1.0	0.5
strontium	1.0	5.0	5.0
vanadium	1.0	1.0	0.5
zinc	10	5.0	1.0

The recommended detection limit for methyl mercury in water is 0.5 ng/L.

Prior to use at each collection site, all collection and processing equipment should be washed with a brush and mild phosphate-free detergent-deionized water solution, rinsed with dilute nitric acid, and triple-rinsed with deionized water. Between subsample collections at each site, the collection equipment will be washed with a brush and site water. Dilute nitric acid and detergent used to decontaminate collecting equipment should be retained for appropriate disposal.

4.4. Toxicity Testing

Several test organisms and bioassay designs are available to assess toxicity of water. Ingersoll et al. (1992), Dwyer et al. (1992), and Finger et al. (1993) found that *Daphnia magna* was a suitable test organism for toxicity testing in Lahontan Valley. Static tests of short duration (e.g., 48-hr) appear to be suitable for screening purposes. Water used for toxicity testing should be collected in conjunction with water collected for water quality analyses. Sample treatment and testing procedures should follow protocols provided in Weber (1993).

Microtox® provides a rapid method for assessing the relative toxicity of water. The performance of Microtox® toxicity tests should be evaluated as an alternative to toxicity testing using *D. magna*. Testing procedures should follow protocols provided by the manufacturer. If Microtox® is determined to provide a suitable (i.e., sensitive) alternative to assess toxicity, toxicity testing using *D. magna* may be discontinued.

4.5. Fish Condition Assessment

All fish captured during fishery survey efforts as part of the biological monitoring program or Wetland Contaminant Sampling (section 3.3) should be identified to species level and counted. Past fish collection efforts found that minnow traps and trap nets were most effective in capturing fish on Stillwater NWR (Tuttle et al. 2000). Up to 25 fish of each species from each location should be weighed, measured, and examined for external abnormalities. External abnormalities may include teratogenic deformities (i.e., lordosis, scoliosis, kyphosis, abnormally shaped heads, or missing or deformed fins, gill covers, eyes, or mouth), lesions, tumors, protrusions, or parasitic infections. The species, size, weight, and abnormalities of each fish examined should be recorded on a data form (Appendix B). Fish to be examined should be selected at random. Length and weight data should be used to calculate Fulton's condition factor for each fish and the species for each location. The types and frequency of abnormalities should also be recorded by site.

4.6. Assessment of Indicators of Endocrine Disruption

To evaluate endocrine system effects in fish, 10 female and 10 male adult carp should be collected from each of the primary water delivery routes entering Stillwater NWR. Fish should be collected in May and June using trap nets. Sampled fish should be weighed, measured, and visually inspected for external lesions, parasites, and other abnormalities then released. All sampled fish should be marked (e.g., fin clip or floy tag) to prevent resampling of same fish. Approximately 5 cubic centimeters (cc) of whole blood should be collected from the caudal peduncle of each fish and placed in lithium-heparinized vacutainer tubes. The blood samples should be centrifuged at 10,000 RPM for 10 minutes. Blood plasma should then be separated from packed cells with a pipet, and frozen on dry ice. Plasma samples should be submitted to the Florida Caribbean Science Center for analysis of 17B-estradiol, 11-ketotestosterone, ethynyl-estradiol, and vitellogenin. Analyses should follow methods described in Goodbred et al. (1997).

4.7. Aquatic Community Assessment

Several methodologies and structural indices are available to assess aquatic community health. Previous monitoring efforts under NIWQP (Tuttle et al. 2000) adapted methodologies recommended by Miller et al. (1988), Plafkin et al. (1989), and Newman (1995). This information may serve as a baseline for future assessments on Stillwater NWR.

Benthic and nektonic invertebrates should be collected in conjunction with samples collected for chemical analysis for Wetland Contaminant Sampling (Section 3.3). Benthic invertebrates should be collected with an appropriate core sampler. Each sample should consist of a composite of 10 sediment samples collected at a depth of 5 cm. Samples should be sieved through an 800 µm nylon mesh. Nektonic invertebrates should be collected with consistent effort with an appropriate net (i.e., kick net). Collected invertebrates should be preserved in 70 percent ethyl alcohol for later sorting and identification. Invertebrates should be identified to the lowest possible taxonomic level and counted. Taxa richness, taxa heterogeneity (Shannon's Index), and taxa evenness should be calculated using methods described in Newman (1995).

Fish collected as part of fishery survey efforts as part of the biological monitoring program or Wetland Contaminant Sampling (section 3.3) fish condition assessment may be used to evaluate fish community composition and structure. Methodologies recommended by Miller et al. (1988) and Plafkin et al. (1989) should be followed.

5. DATA MANAGEMENT AND REPORTING

All water quality and environmental contaminant data should be entered into the comprehensive database developed as a component the Stillwater NWR Biological Monitoring Program. These data should be reviewed and reported annually. Of primary interest are changes in water quality variables and environmental contaminant concentrations on a temporal and geographic scale. Such changes may indicate progress toward the attainment of biological and contaminant objectives. Data should also be used to evaluate the interrelation of water quality, environmental contaminants, and biological characteristics. Annual reports should evaluate and recommend management measures to further the attainment of biological and environmental contaminant goals of Stillwater NWR.

6. DISPOSAL OF INVESTIGATION DERIVED WASTE

6.1. Decontamination

Dilute nitric acid and detergent used to decontaminate collecting equipment should be retained for appropriate disposal.

6.2. Personal Protective Equipment

Personal protective equipment used in this investigation will include latex gloves and hip boots or chest waders. Disposable sampling equipment and personal protective equipment should be rendered unuseable and disposed of as nonhazardous municipal solid waste at a local landfill. All such waste should be placed in a sealed plastic bag prior to disposal. Boots should be cleaned with a brush and mild detergent and retained for further use.

7. DOCUMENTATION AND SAMPLE SHIPMENT

7.1. Logbook

A logbook of monitoring activities should be maintained. Field logbooks should document where, when, how, and from whom any vital information was obtained. Site coordinates for all sample collection sites will be recorded in the log book. Photographs should also be taken of sampling sites and frame numbers will be recorded. Logbook entries should be complete and accurate enough to permit reconstruction of field activities.

7.2. Sample Labeling

All samples collected during the monitoring program should be labeled in a clear and precise way for proper identification in the field and for tracking in the laboratory. The samples should have preassigned, identifiable, and unique numbers. Pre-printed sample labels should be used to label jars. Information on pre-printed labels should include: Client/source, site name, date/time of collection, sample number, analytical parameter(s), and method of preservation.

7.3. Packaging and Shipment

All samples should be shipped in a hard-shelled cooler. Water samples should be shipped with wet ice or blue ice. Frozen samples should be shipped with dry ice. When wet ice is used, it should be packed in zip-locked, double plastic bags. The drain plug of the cooler should be sealed with fiberglass tape to prevent melting ice from leaking out of the cooler. When dry ice is used, it should be placed in the cooler in it’s original package and an appropriate label denoting that the cooler contains dry ice should be placed on the front of the cooler prior to shipping. Proper documentation denoting the occurrence and amount of dry ice within the shipping container should also be provided to the shipper.

Screw caps of all sample containers should be checked for tightness and, if not full, the sample volume level of liquid samples should be marked on the outside of the sample bottles with indelible ink. Container tops should be secured with clear tape and the sample labels should be affixed onto the containers with clear tape. Glass sample containers should be placed in original shipment boxes to prevent breakage. All other sample containers should be enclosed in heavy duty plastic bags and the sample numbers should be identified on the outside of the plastic bags with indelible ink.

All samples will be placed in coolers with the appropriate forms. All forms should be enclosed in a large plastic bag and affixed to the underside of the cooler lid. Empty space in the cooler should be filled with newspaper to prevent movement and breakage during shipment. Ice used to cool samples should be double sealed in two zip lock plastic bags and placed on top and around the samples to chill them to the correct temperature. Each ice chest should be securely taped shut with fiberglass strapping tape.

8. QUALITY CONTROL

Quality control in the field should include strict adherence to the field sampling methods described in Section 4. Laboratory quality control will be the responsibility of the recipient laboratory. Duplicate samples should be collected to account for approximately 10% of total number of samples. Duplicates should be collected from areas known or suspected to have moderate to severe levels of contamination. One equipment blank will be analyzed at the beginning of the study which will consist of deionized water rinsed over the surface of sorting equipment (i.e., stainless steel pan and tweezers). The rinsate will be collected in a 250 ml container and submitted as an individual sample. If analysis of the equipment blank indicates unacceptable levels of contamination, additional equipment blanks will be collected and analyzed. Additionally, trip blanks will be collected for contaminant sampling events. Trip blanks will consist of deionized water subjected to field conditions during sampling events. All duplicates and blanks should be treated as discrete samples and submitted for appropriate chemical analyses.

Analytical accuracy in the laboratory should be assessed using matrix spike/matrix duplicates, laboratory blanks, and certified reference material. A QA/QC report including a brief narrative should be provided by the analytical laboratory. Criteria for acceptability will conform with standards specified by the Fish and Wildlife Service Patuxent Analytical Control Facility or a USGS laboratory, if used.

9. ESTIMATED OPERATIONAL EXPENSES

Annual Operational Costs - U.S. Fish and Wildlife Service

Equipment		$ 1,000
Supplies		500
Analytical - total (water; from Table 1)		40,150
Total dissolved solids	500	
Major ions	2,300	
Nutrients	1,200	
Suspended solids	1,100	
Bacteria	300	
Trace elements (including total Hg)	5,300	
Methyl mercury	4,300	
Pesticides	21,000	
Acrolein (estimated)	3,500	
Total mercury (extra samples, without flood event)	650	
Staff time		25,000
<u>Total annual costs</u>		<u>$ 66,650</u>

Triennial Assessment Costs

Equipment	$ 300
Supplies	300
Analytical - total (trace elements; from Table 2)	28,000
Staff time	15,000
<u>Total triennial costs</u>	<u>$ 43,600</u>

Additional costs for the Service may be required for assessment of minor refuge inflows, toxicity testing, and mercury transport in a flood event. The above costs also do not include an assessment of indicators of endocrine disruption; we will attempt to obtain Service funding for one round of monitoring of this type. Also, we recommend that wetland monitoring (triennial assessment) begin as soon as possible, because the last year of this type of monitoring was in 1996. Analytical cost estimates are based on Service contract laboratories and not on those of USGS.

Annual Operational Costs - U.S. Geological Survey Gaging Stations

The Bureau of Reclamation is currently paying the costs of operation of three gaging stations (i.e., D-Line, Diagonal Drain, and Carson River downstream of Sagouspi Dam). This includes flow for all three sites and temperature and specific conductance at the first two sites. Stillwater NWR pays the operational costs for the S-Line Canal site which includes flow, temperature, and specific conductance; however, this site is only operated during the irrigation season. It is unclear as to whether these agencies would continue to pay for operational costs at these sites. Year round operation of the S-Line Canal site is recommended as flows may occur there during the non-irrigation season. Costs per site if all are operated year round are as follows: flow $13,600; temperature and specific conductance $6,800. Total yearly costs for operation of these sites therefore would be **$81,600**. The estimated cost to add equipment for temperature and specific conductance at the Carson River site should not exceed $3,000.

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Appendix A - Field Data Collection Form

STILLWATER NWR CONTAMINANT MONITORING
FIELD DATA FORM

Wetland: ___________________ No.: ____ Date: ____/____/____ Time: _________

UTM: _________________e _________________n Samplers: ________________________

Field Conditions

Ambient Temp: _____ºC

Weather Conditions: ________________________

Wind: _________________________

Water Movement: __________________________

Water Quality Data

Water Depth: ________ cm

Water Temp.: _______ºC

D.O.: ________ mg/L

Spec. Cond.: ________ : S/cm

Salinity: ________ ppt

pH: __________

Turbidity: ________ NTU

Redox: _____________

Water Color: __________

Sample Collections

Water:

Sample No.: __________________ Analyses: __________________

Sample No.: __________________ Analyses: __________________

Sample No.: __________________ Analyses: __________________

Sample No.: __________________ Analyses: __________________

Sediment:

Sample No.: __________________

Sample No.: __________________

Sample No.: __________________

Vegetation:

Sample No.: __________________ Species _________

Sample No.: __________________ Species _________

Sample No.: __________________ Species _________

Appendix A - Field Data Collection Form

STILLWATER NWR CONTAMINANT MONITORING
FIELD DATA FORM (*continued*)

Wetland: ___________________ No.: ____ Date: ____/____/____ Time: _________

Sample Collections

Invertebrate:
- Sample No.: __________________ Species _________ Dominant Size: ______ mm
- Sample No.: __________________ Species _________ Dominant Size: ______ mm
- Sample No.: __________________ Species _________ Dominant Size: ______ mm

Fish:
- Sample No.: __________________ Species _________ Size: __/___/___/___/__ mm
- Sample No.: __________________ Species _________ Size: __/___/___/___/__ mm
- Sample No.: __________________ Species _________ Size: __/___/___/___/__ mm

Avian Egg
- Sample No.: __________________ Species _________
- Sample No.: __________________ Species _________
- Sample No.: __________________ Species _________
- Sample No.: __________________ Species _________
- Sample No.: __________________ Species _________

Juvenile Bird
- Sample No.: __________________ Species _________
- Sample No.: __________________ Species _________
- Sample No.: __________________ Species _________
- Sample No.: __________________ Species _________
- Sample No.: __________________ Species _________

Appendix B: Fish Assessment Data Form

Stillwater NWR Contaminant Monitoring Date: ___/___/___ Form: _____ of _____

Data Form: Fish Assessment Site: ______________________ Assessment Personnel: __________________________

no.	species	length (mm)	weight (g)	sex	spinal column[1]	fins[1]	opercle[1]	eye[1]	head[1]	mouth[1]	gill[1]	lesions[2]	para-sites[2]	picture roll frame

[1] N (normal); A (abnormal, see comments)

[2] N (normal); P (present, see comments)

Stillwater NWR Contaminant Monitoring Date: ___/___/___

Data Form: Fish Assessment Site: ________________________________

Assessment Personnel: __________________________

Comments

no.	comment

Appendix C

HEALTH AND SAFETY PLAN
FOR
ENVIRONMENTAL CONTAMINANTS MONITORING PLAN FOR STILLWATER NATIONAL WILDLIFE REFUGE

1. Purpose

The purpose of the Health and Safety Plan (HASP) is to define the requirements and designate the protocols to be followed during the field work specified under Occupational Health and Safety Administration (OSHA) 29 CFR 1910.120(b) Final Rule. All Fish and Wildlife Service (Service) personnel involved in environmental contaminants monitoring for Stillwater National Wildlife Refuge (NWR) must be informed of site emergency response procedures and any potential health or safety hazards related to investigation activities. A copy of the HASP will be provided to all personnel involved in this investigation. This HASP must be reviewed and approved by the Nevada Fish and Wildlife Office (NFWO) Health and Safety Officer and the Field Supervisor.

2. Health and Safety Plan Enforcement

A NFWO Resource Contaminants Specialist will be responsible for implementing and enforcing the health and safety provisions of this HASP, and will ensure that all participants abide by its requirements.

3. Site Background

a. Contaminant Types:

Arsenic, boron, mercury, and other trace element contamination in water, sediment, and biota. Possible pesticides, organic contaminants, bacteria, and sewage effluent in water.

b. Location:

The project area includes Stillwater NWR and delivery canals, Churchill County, Nevada.

c. Physical Description:

Monitoring sites include a series of shallow wetlands, uplands, water delivery canals, and agricultural drains.

d. History:

A history of contaminant concerns is provided in the Environmental Contaminants Monitoring Plan for Stillwater NWR.

e. Surrounding Population:
Population centers in the project area include the town of Fallon and the Fallon Paiute-Shoshone Indian Reservation. A number of farms also occur outside of the population centers. Additionally, wetlands in the project area provide a variety of recreational activities, including hunting and fishing.

f. Topography:
The site is relatively level, with wide spread depressions and incised water channels.

4. Hazard Evaluation
The field activities to be conducted present a variety of chemical and physical hazards. Actual personnel exposure to these hazards are dependent on the specific work tasks, weather conditions, levels of protection utilized, and personal work habits.

The identified potential hazards associated with this project are:

Chemical
Biological
Mechanical
Unstable/Uneven Terrain
Insect and Animal Stings or Bites
Noise
Inclement Weather
Drowning

4.1. Chemical and Biological Hazards
Primary chemical hazards include trace elements, whereas the primary biological hazard is sewage effluent. Nitric acid will be used to clean equipment. Exposure to pesticides, organic compounds, and sewage effluent is possible. To minimize contact and exposure, latex gloves and rubber boots will be worn when collecting or handling samples. All personnel will wash hands after collecting or handling samples.

4.2. Mechanical Hazards
Field work in this investigation may require the use of an airboat. All persons that will operate the airboat have completed a Department of the Interior Boat Safety Course and have been certified as boat operators. To avoid injury, all personnel on the airboat will be seated in designated seats while the airboat is in operation.

4.3. Unstable/Uneven Terrain
Field collections will occur in marsh areas, and the terrain will be uneven and muddy. Care will be exercised by field personnel.

4.4. Insect and Other Animal Stings and Bites

A potential for insect or other animal stings or bites exists during field data and sample collections. Insect repellent may be used to minimize insect bite hazards. In the event of snake or other large animal bite, the injury will be immobilized and immediately reported to qualified medical personnel. All field personnel will be notified of animal hazards at the initial safety meeting. Appropriate clothes should be worn.

4.5. Noise

Noise will be a hazard during the operation of airboats. Hearing protection, including ear muffs and inserts will be worn by all personnel when the airboat is in operation.

4.6. Inclement Weather

Severe weather conditions may generate lightning or flooding hazards. All site personnel will be responsible for monitoring weather conditions. If a potential for significant thunderstorm activity exists during field activities, personnel will not be allowed in the field during the threat period. Personnel will take refuge in enclosed vehicles. Vehicles will not be driven in potential flood areas.

4.7. Drowning

Drowning may be a hazard in field activities. At least two persons will participate in all field activities. Personnel will not enter water more than 3 feet deep. Data and sample collections in deeper water will occur from an unmoving boat. All persons on the boat will wear a U.S. Coast Guard approved flotation device.

5. Training Requirements

The Resource Contaminants Specialist responsible for implementation of the program will have completed a 40-hour training course on Hazardous Materials Response Operations and has completed an annual 8-hour Hazardous Waste Site Operations refresher course. Prior to involvement in any field activity, all personnel will attend a safety briefing. The briefing will include the nature of the contamination, normal operating procedures, and emergency operating procedures. Included in the initial briefing will be a review of:

Visual emergency signals.
Equipment capabilities and limitations.
Nature of hazards and consequences of failure to use personal protective equipment.
Emergency procedures.
Contents of the Site Safety Plan and the individual's responsibilities and duties in an emergency.
Review of MSDS or equivalent for the toxic chemicals and materials present on site.

6. Personal Protection Requirements

6.1. Levels of Protection

Personal Protective Equipment shall be appropriate to protect against known and potential health hazards encountered during routine sampling.

6.2. Protective Equipment and Clothing

Protective equipment and clothing, including vinyl or latex gloves, eye protection, and rubber boots will be worn by all personnel involved in field activities.

7. Medical Surveillance

7.1. Health Monitoring Requirements

The Resource Contaminants Specialist will successfully complete a physical examination. The examination will comply with OSHA 1910.120 requirements for hazardous waste site operations and will include:

- Occupational and general physical history.
- Complete physical examination which incorporates the head, torso, abdomen, limbs, and musculo-skeletal system.
- Chest x-ray, which may be waived in the judgment of the physician.
- Pulmonary function test.
- Audiometric test.
- Standard laboratory testing of blood and urine.
- Vision test.
- Electrocardiogram, which may be waived in the judgment of the physician.

The following will be provided to the examining physician:

- Description of examinees duties.
- Anticipated exposure levels.
- Description of personal protection equipment requirements.
- Information from previous medical examinations.

The examinee will be informed of any medical conditions that would result in work restrictions that would preclude work at a hazardous waste site.

8. Documentation and Record Keeping Requirements

Medical and personnel exposure monitoring records will be maintained in accordance with the requirements of 29 CFR 1910.120 and 8 CCR 5192.

8.1. Medical Support and Follow-up Requirements

In the event of a chemical exposure, injury, or illness, the principal investigator and the NFWO Health and Safety Officer will promptly initiate the steps necessary to identify the chemical(s). Chemical identification will be accomplished through the use of monitoring equipment and any available prior sampling data. The chemical agent(s) information will be made available to the treating physician.

Any injury or illness not limited to a first-aid response will require the principal investigator to immediately notify the NFWO Health and Safety Officer and the Field Supervisor.

9. Safe Work Practices

The Service will provide the required training and equipment for their personnel on-site to meet safe operating practices and procedures and will be responsible for the safety of their workers.

10. Health and Safety Plan Enforcement

A "three warning" system to enforce compliance with the Health and Safety Plan will be used.

First infraction--violator receives a verbal warning.
Second infraction--violator receives a written warning.
Third infraction--violator will be requested to leave the site.

11. Decontamination

11.1. Personnel Decontamination

Gloves will be disposed of following use at each collection site. Boots will be cleaned after use at each site. Field personnel will wash hands after collection or handling of samples collected during this investigation.

11.2. Equipment Decontamination

Sampling equipment and tools affected by site contamination will be decontaminated using a water solution of Alconox or Citranox, rinsed with deionized water, rinsed with a dilute nitric acid solution, and rinsed with deionized water. All contaminated site equipment will be decontaminated both before and after site activities. All uncontaminated equipment should be wiped with a wet towel at the close of site activities.

Decontamination solids will be containerized and disposed of in an appropriate land fill. Decontamination solutions containing acid will be stored in a suitable container and disposed of at least yearly through a certified waste disposal company.

12. Emergency Contingency Planning

The objective of the Health and Safety Plan is to minimize chemical and physical hazards and operational accidents. The following directions are provided to ensure personnel respond to emergency situations in a calm and reasonable manner.

Prior to commencement of field operations, an emergency medical assistance network will be established. Emergency phone numbers are listed in Section 13. A vehicle will be available on-site during all activities to transport injured personnel to the identified emergency medical facility. A cellular telephone and a list of emergency telephone numbers will be available in the field. A first aid kit, emergency eye wash, and an adequate supply of potable water will be available in the field. The Resource Contaminants Specialist will lead in all emergency situations, unless disabled, in which case the next most senior personnel will lead.

13. Emergency Information Telephone Numbers

Monitoring Lead	
Resource Contaminants Specialist, NFWO	(775) 861-6300
Nevada Fish and Wildlife Office Safety Officer	
Damian Higgins	(775) 861-6300
Nevada Fish and Wildlife Office Supervisor	
Robert Williams	(775) 861-6300
Paramedic Ambulance	911
Churchill County Community Hospital	(775) 423-3151
Center for Disease Control	(404) 329-3311
National Response Center	(800) 424-8802

14. Hospital Location

The Churchill County Community Hospital is located at 155 N. Taylor Street in Fallon, Nevada.